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DESIGN, CONSTRUCTION, OPERATION OF METAL-WORKING AND ALLIED EQUIPMENT

MACHINERY

JULY, 1942

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The production of powdered-metal parts is a subject that is new to the average engineer and machine designer. Yet it is a process that is becoming increasingly important. It opens up an entirely new and highly promising field in machine construction. New uses are being found for powdered-metal parts daily. For that reason, the leading article in August MACHINERY, ***What a Machine Designer Should Know about Powdered Metals,*** will prove of interest and value to progressive men in the mechanical industries.

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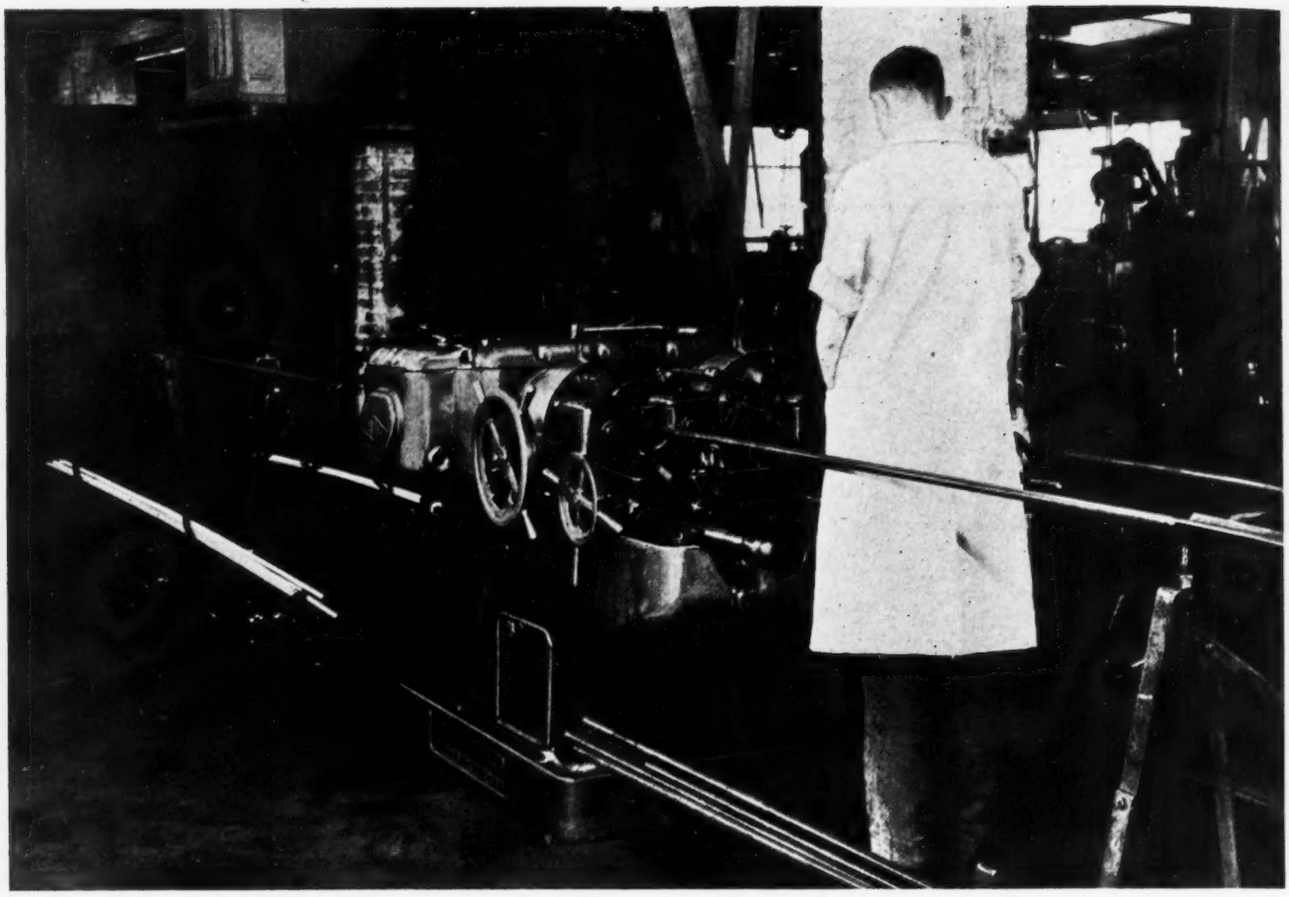

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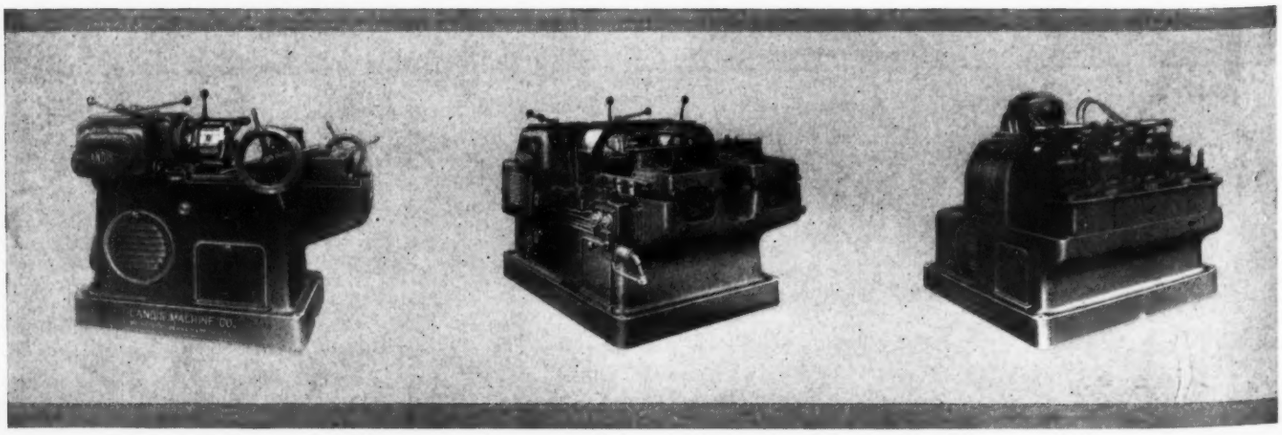


LOCKHEED P-38, BELL P-39 AND CURTISS P-40 WITH ALLISON ENGINES, AND REPUBLIC P-43 WITH A PRATT & WHITNEY ENGINE—ALL EQUIPPED WITH CURTISS ELECTRIC PROPELLERS

Sixty Thousand Planes This Year!

WHEN President Roosevelt made his electrifying demand for 60,000 airplanes in 1942 and 125,000 additional planes in the following year, there were many who felt these figures to be fantastic. Six months have shown that the President's confidence in the capabilities of American industry was fully justified. Record-breaking production throughout the aircraft industry and in the thousands of small shops that have turned from peacetime products to the making of detail airplane parts insures the attainment of what so recently appeared to be an almost impossible goal.

This production miracle has been achieved by the application of the latest metal-working machines and methods evolved by machine tool builders and aircraft production engineers working in cooperation. The technical information contained in this issue of MACHINERY—the Fifth Annual Aircraft Production Number—will be of great value in expanding aircraft output to even greater volume. All the articles in the special aircraft section were made possible through the generous cooperation of the United States Army Air Force and have been approved by the War Department.

MAJOR GENERAL OLIVER P. ECHOLS

Commanding General, Materiel Command
United States Army Air Forces

American Aircraft Can Win the War

The Materiel Chief of the Army Air Forces Acclaims the Achievements of the Aircraft Industry and Portrays the Yet Greater Job Now Facing It in Securing the Future of Our Country and Its Allies

By MAJOR GENERAL OLIVER P. ECHOLS
Commanding General, Materiel Command
United States Army Air Forces

GIVE us the tools, America, and we'll fight!—This was the cry that rang out through the Battle of Britain. This is today's cry from our own airmen on the far-flung, unnumbered American battlefronts to their fellow warriors in the industries at home which are striving to fill the skies with American warplanes.

In less than two years' time, Air Power has become the most discussed topic in the American press—and even more significant, in every American home. Officers of the U. S. Army Air Corps of my generation have been firmly convinced for many years that the next war would be, to a large extent, an air war. It has been a long, hard task to convince our people that aviation had the reliability, mobility, and striking power which we believed it possessed. The idea of air power has been difficult to sell.

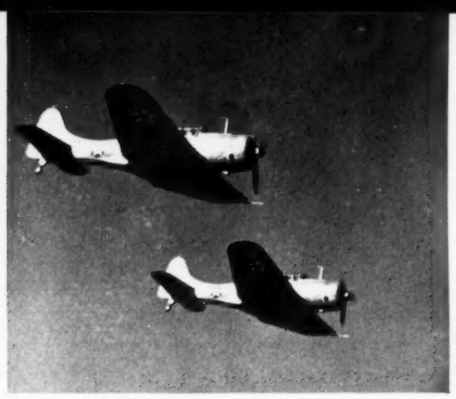
It took the fall of France, the Battle of Britain, Crete, the Lybian campaign, Pearl Harbor, the Philippines, Singapore, Java, and now Burma to do the selling job. With each loss suffered, the case for air power has been borne home to the American people with greater vigor, greater significance.

The Axis powers had that greatest of military advantages which belong to aggressor nations—they planned their aggression years in advance. At the time of the Munich Conference, the German air force had been some four years in the building, while the U. S. Army Air Corps had only 1773 airplanes. The foreshadowed events which were shortly to sell the American people on Air Power were even then considered "the fancies of alarmists, the tool of propagandists."

In spite of the President's efforts to build an air force, it was not until the fall of France that the people of the nation were sufficiently aroused from their complacency to demand that the United States become an Air Power. The Air Corps was then, in June, 1940, given funds for 3000 planes, and in September, another allotment was made for 18,000 additional planes.

We were given two and one-half billion dollars and told to build an air force overnight. With an industry which had been on a starvation diet all of its life and had never been called upon to build more than a few hundred airplanes per month, a large percentage of these being commercial, we were expected to place orders and begin to produce thousands of combat airplanes.

The problem which the industry faced was extraordinarily complex. First of all, plant facilities had to be multiplied many times over. Second, owing to the urgency of the military situation, airplanes had to be turned out even while the extensions and the new factories were being built. Third, in order to retain the edge of superiority in types, it was necessary to work in several new advanced models while tapering off production on the established types. We shall notice one or two examples of this as we proceed. Finally, as we shall see in some detail presently,



the aircraft industry had to train the automotive industry in the construction of airframes and aircraft engines.

Up to this time, while trying to sell the nation Air Power, the Army Air Corps, with such meager funds as could be obtained, had been plugging away at the development of those types of models of military airplanes which it believed were necessary for the use of a well rounded air force for the war which was to come.

Our object was to build Air Power. We did not know *when* the next war was coming or *where* our airplanes were to be used, but modern military airplanes cannot be designed and produced overnight. Their complexity is such that it requires two years to get a modern plane in production. These airplanes had to be *ready* for production at the beginning of the emergency when it did come, or else it would be too late. And so they were ready!

For example, one urgent need of the hour was to supply the air forces of the United Nations with a fighter plane which could be hurled into battle at once without waiting for the coming of a "super" airplane. This was done by starting full-scale production on the Curtiss P-40 series, the first of our modern fighters to use the Allison V-type liquid-cooled engine. Within a few months of the all-out emergency, which may be dated from June, 1940, with the rapid over-running of the Low Countries and the collapse of France, P-40 B's and C's were coming off the line at the rate of several per day. Known as the Tomahawk by the R.A.F., these planes, improved over the original type P-40 by the use of heavier firepower, armor plate for pilot protection, etc., have proved more than a match for the best the enemy could offer. In the Middle East, in the hands of R.A.F., Australian, and South African pilots, the Tomahawk became practically standard equipment, and repeatedly took the measure of greatly outnumbering squadrons of Messerschmitt 109's.

At Pearl Harbor, the Philippines, the East Indies, and the Australian sector, P-40 B's and C's, and the further improved P-40 D's and E's (called the Kittyhawk by the British) have been effective against vastly greater numbers of Jap planes, including their best fighter plane, the Zero. Reports from the American Volunteer Group of "Flying Tigers" in Burma and China under Brigadier General Claire Chennault, using their P-40's with amazing skill and resourcefulness, indicate that up to early May over 450 Japanese planes have been accounted for, with a loss ratio of 30 to 1 for planes and 90 to 1 for pilots.

Another good example is our Boeing B-17 long-range bomber, the Flying Fortress. This type, pioneered by the Air Corps in 1936, was ready for production at the outbreak of the emergency, and successive models of it have been improved. The ceiling and top speed have been raised to over 35,000 feet and more than 300 miles per hour, respectively, through the use of turbo-superchargers. Armor, leak-proof gas tanks, power-driven turrets and "stinger" tail guns have been added, and while this has meant several tons of increased weight, the result has been the most effective and formidable heavy bomber in action today. Although no surprise to our Air Force officers or to the aircraft industry, the consistent performance and ability of the B-17's to batter their way through enemy fighter opposition, bomb their objectives, and return to their bases in spite of savage punishment has been a matter of exultation on the part of the American public and consternation to the Japs.

These examples illustrate what I mean in saying that tried and proved types had to be ready. They also show the importance of flexible production—a semi-freezing of designs to provide for as large-scale production as possible, and yet allow vital changes (and I mean vital) to be worked in at various stages of the job, as found necessary for improved performance.

Due to the well made plans of the War Department and the patriotic attitude of the aircraft industry, we were able to place orders for this entire program within less than two months from the time the funds were authorized. The 21,000 plane program referred to was immediately increased, as the President had set a goal of 50,000 airplanes per year for the Army and Navy. This objective, heretofore considered impossible, was now in sight. It was quite an accomplishment. Then came Pearl Harbor! The whole military strategy of ages was changed overnight. We had been hurled into a global air war.

The President, in his Directive of January 3, 1942, stated that we would produce 185,000 airplanes within two years. This meant that, in 1943, we would have to reach a productive rate of more than 10,000 airplanes per month. This was an entirely different problem. It called for a complete resurvey of the national economy with reference to labor, management, materials, and machine tools.

In our initial expansion program, we had relied almost entirely on the aircraft industry. Plants were built. Management was thinned out. Labor was trained. New machine tools were procured. The aluminum and magnesium industries were expanded. Although the aircraft industry had responded in a most magnificent manner, it soon became apparent that management would become a serious problem in any further expansion. It was evident that in the event of a real emergency, involving our entire industrial effort, the great automobile industry, and hundreds of smaller industries whose facilities could be converted to the needs of the aircraft industry, would have to be relied upon to carry a great proportion of the aircraft load.

Undertaking to bring these outside industries into the Aircraft Production Program has been an immense job. We have had to transmit to new manufacturers the "know-how" of building aircraft, engines, and accessories. A large number of these production models were new and untried, and the engineering drawings and data in many cases had not gone beyond the experimental shops. To get the necessary engineering data from the aircraft manufacturer and his vendor to the sub-contractor's production line has not been an easy problem.

Further, there have been and still are certain honest differences of opinion, based on different experiences, as to the best methods and procedures. For example, conversion of the automobile industry was complicated by the fact that the automobile manufacturer works in hard materials, whereas the aircraft manufacturer works in soft materials. The aircraft manufacturer is accustomed to change, with his series of small orders, each requiring changes and improvements. Often being required to go into production on an unproved article, and to remedy defects in the production line, he has become nimble, alert and versatile.

It is greatly to the credit of the aircraft industry that, with the tremendous load of their own, they have turned over their designs and spent unsparingly of their time in assisting the War Department in the conversion of other industries.

Prior to our entry into the war, much progress had been made toward the conversion of the automobile industry to a war effort. In the aircraft engine field, engines, propellers, bomber wings, gun turrets and parts, and many aircraft accessories were being built by the automobile industry. With this experience behind them, the conversion to the all-out war effort called for by our entry into the war, and the discontinuing of automobile production, was made without delay. To anyone who has followed this great conversion from day to day, it is apparent that the American industry can produce, and soon will be producing, airplanes to the limit of the available raw materials.

The cooperative spirit with which both the aircraft manufacturers and the automobile in-

dustry have attacked the problem of all-out aircraft production is exemplified by the joint projects undertaken by the various groups of manufacturers who are pooling their engineering skill and production facilities with the view of accelerating the mass production of bombers.

As a result, the production of warplanes today meets all schedules set by the Government. In the six months after Pearl Harbor, the output of heavy four-engine bombers alone increased almost 300 per cent. These are the planes that are already bringing destruction to the Axis homelands. The production of aircraft engines has more than doubled since the end of 1941.

It is not generally realized that the aircraft manufacturer does not manufacture the complete airplane. He designs the airplanes, based on military requirements and type specifications furnished him by the Air Corps, and he manufactures a large part of the airframe. But the engines, propellers, wheels, generators, a large part of the electrical system, including all of the radio, and most of the armament equipment, including gun turrets and sights, bombsights, automatic pilots, turbo-superchargers, navigation equipment, and many of the instruments, are furnished by the Government. They are designed to Government specifications, purchased by the Government, furnished by it to the manufacturer, and known as G.F.E.

In addition, there is a large amount of so-called "vendor-furnished" equipment, which is procured by the manufacturer from sub-contractors. These include hydraulic equipment, fuel installation and leak-proof gas tanks, landing-gear legs, fittings, and a large number of other small items of equipment. The equipment manufacturers, in turn, have their vendors. For example, the engine manufacturer purchases magnetos, carburetors, spark plugs, crankcases, and bearings. Then there are the fabricated materials such as aluminum forgings, castings and extrusions.

Above all, there is the problem of tools, dies, jigs, fixtures, machinery—for the airplane, engine, accessory, and equipment manufacturers and for the countless sub-contractors, fabricators, and vendors. Little is the general public aware that all these manufacturers are completely dependent, from the word "go," upon an industry that is entirely unrelated to the production of aircraft, yet the products of which are essential to every single phase of aircraft production.

This is the great machine tool industry which provides the machines for the turning, milling, broaching, grinding, drilling, reaming, tapping, shaping, planing, stamping and drawing operations necessary in preparing materials for the assembly lines of the airplane, engine, accessory, and equipment manufacturing plants.

It has been the gargantuan task of this industry not merely to produce *enough* machinery to supply the needs of the aircraft production program, but—and even more vital—to devise *new* tools and machines to do new jobs with speed and accuracy, and to do old jobs with greater speed and accuracy than was possible with the tooling equipment available prior to this emergency. This industry has done a magnificent and little publicized work in enabling the aircraft industry to meet production schedules set by the Government.

Cooperation between the machine tool industry and allied branches of the aircraft production industry has, as much as any other single effort, made possible the meeting of Government schedules, which call for 147,000 airplanes to be produced for the Army Air Corps in 1942-3. Out of this cooperation have come increased capacity, versatility, accuracy, and speed in operation of the tools and machines so vital to the aircraft production industry. Out of it have come equipment especially designed to meet the new mass production needs of the specialized and complicated operations involved in producing our warplanes and all that goes into them. Tribute is also due in large measure to

the concerns who supply the jigs, fixtures, inspection equipment and small tools, which are required in enormous quantities.

The aircraft manufacturer cannot undertake to provide himself with these sources of supply. He looks to the procuring agency of the Government to plan and provide the sources of supply and the materials in such a way that the fabricated materials and numerous items of equipment flow into his shop and into his production line in such a way as to meet his schedules.

The facilities and the "know-how" to manufacture many of these complicated items were almost non-existent in the United States in 1940. It became necessary for the War Department to spend well over a billion dollars either in new facilities or in retooling existing shops to manufacture the airplane accessories necessary for the aircraft program, the Army's share of which will involve the expenditure of approximately twenty-five billion dollars within two years from September, 1940.

Let us look at the types of warplanes which are the subject of this immense combined effort. In anticipating American needs for Air Power during the years prior to the war when funds could not be got to produce that Air Power, the Army Air Force developed combat planes to meet various tactical and strategical needs. In the fighter class we had developed such high-altitude planes for the interception of high-flying enemy aircraft as the Lockheed P-38 (Lightning) and the Republic P-43 and P-47 (Thunderbolt), and also medium- and low-altitude fighter planes for operation against bombers and tanks and for support of ground troops, such as the Bell P-39 (Airacobra), the North American P-51 (Mustang in the R.A.F.), and the Curtiss P-40 series to which we have previously referred.

In bombardment aviation we had such top-notchers as the Boeing B-17 (Flying Fortress) and the Consolidated B-24 (Liberator) well on the way, long-range four-engine aircraft for striking at the enemy's military and industrial objectives, and two of the fastest, most powerful two-engine bombers in the world, the Martin B-26 and the North American B-25, the latter having scored notable successes in the raid on the Philippines from Australia and the first bombing of Japanese cities.

Among light bombers, our Douglas A-20 is emerging as one of the most useful and versatile airplanes now in operation. Equipped with two 1700-H.P. Wright Cyclone engines, this airplane combines the best features of the attack plane and a light, fast bomber, for use with ground troops or short-range independent operations. The British use it as a special night fighter plane under the name Havoc, and many R.A.F. pilots prefer it to other types; under the name Boston, the R.A.F. Bomber Command has been using it with conspicuous success as a fast low-flying fighter-bomber in daily operations over the channel ports and occupied France.

These are, in general, our production airplanes. I know of no case in this war where they have not been able to more than hold their own with the best the enemy has had to offer. This is only a beginning. Other and better planes, in each category, are in the experimental shops, and some of them are already on the production lines. We have more than twenty new types of combat planes in process of development today. Besides, in the all-important field of fast, long distance supply, we are procuring large fleets of troop and cargo transport planes and gliders.

In the long run, an airplane is no better than its engine, and it is thus of more than passing interest to note that in the radial air-cooled engine field, the Wright Aeronautical Corporation engineers have developed a process for mass output of forged cylinder heads which make them not only faster to produce, but also lighter, much stronger, and with improved cooling at both low and high altitude. This triumph in the battle of production will give the airplanes of

the United Nations a greater speed, load, range, and ceiling than present combat models.

However important the production of great numbers of planes may be, we cannot sacrifice a single aspect of quality for the sake of quantity. The Materiel Command is responsible for maintaining that quality and superiority through constant experiment, development, and testing. One of the most important jobs of the Materiel Command of the Army Air Forces is to insure that our airplanes can fly faster, higher, and are more heavily armored, carry greater fire power, are more maneuverable, have longer range and greater bomb- and troop-carrying capacity than those of the enemy. Our combat aircraft are the finest in the world.

The goal of American Air Power is not an easy one to attain—147,000 airplanes to be produced for the Air Corps in two years, 70,000 pilots per year to be trained, and a 2,000,000 man Air Force. And these are exclusive of the Navy Air program. Such figures would have been considered fantastic a few months ago. Are we going to reach this goal? I see no reason to be discouraged. The training program is making splendid progress, and the great manufacturing plants which have been in process of construction and tooling up are now in production. We are producing more aircraft than any other nation now, and in another few months our production will be overwhelming.

With more superior plane types in process of development and nearing the production line, including super-bombers and fast, powerful fighters, and with the flexibility of production inherent in our resources and experience, we are bound to break enemy resistance by the successive impact of ever increasing quantities and newer and deadlier air weapons.

During the first few months since our active entrance into the world conflict, our air power has been spread dangerously thin. American airplanes were called for in all parts of the world—to replace losses in Hawaii and the Philippines; for east and west coast defense, Alaska, and the Caribbean; for operational training; for Britain, North Africa, Russia, China, India, Australia—the cry was "More planes. Send us more planes!"

Soon, however, we shall have the air power to pass to the offensive, and not only recapture lost ground, but strike powerful blows directly at Germany and Japan and establish that dominant air superiority which is necessary to permit our ground and naval forces to operate against the enemy. That superiority once gained, the Axis powers will have lost the initiative which they have largely held up to the present time as a result of their carefully planned aggression, and once on the defensive, their ultimate defeat is certain, and Victory, with the hope of a new world, will be ours.

★

CURTISS HELLDIVER SB2 C-1 DIVE BOMBER

Wright-Aero Plant Revolutionizes Engine Production

By P. W. BROWN, Assistant Works Manager
Wright Aeronautical Corporation

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Fig. 1. (Above) Mass Production on a Scale heretofore Unknown in Aircraft-engine Manufacture has been Facilitated in a New "Wright Aero" Plant by Installing Miles of Power-driven and Gravity Conveyors

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Fig. 2. (Below) Gravity Conveyor on which Cylinder Barrels by the Hundreds are Carried to Successive Machining Operations. The Conveyor is Shown Extending along a Battery of Mult-Au-Matics

Wright-Aero Revolutionizes Engine Production

Mass Production on a Scale Hitherto Unknown in Aircraft-Engine Building is Attained in a Plant that is Laid Out on the Principle of In-Line Production and Equipped with Miles of Work-Carrying Conveyors

By P. W. BROWN, Assistant Works Manager
Wright Aeronautical Corporation

REAL mass production in the manufacture of airplane engines became feasible during the last two years with the realization by military men that victory in this war will depend largely upon air power. The placing of heavy orders for engines warranted the building of huge factories and equipping them with high-production machine tools of standard and single-purpose types. A tremendous factory expansion has been effected by the Wright Aeronautical Corporation and further expansion is under way. This article will describe operations in one of the new plants, which ranks among the finest machine shops in the world. It is entirely air-conditioned.

This shop is completely laid out on the principle of in-line production for the manufacture exclusively of Cyclone "double-bank" fourteen-cylinder radial air-cooled engines of 1700 horsepower. From raw material storage and receiving departments at one end of the plant, the work moves continuously in practically a straight line to the inspection department, which extends across the shop near the far end of the building. From the inspection department the checked parts go directly to the final assembly lines, which are separated by a wall from the remainder of the shop.

The problem of handling work between machines has been greatly reduced through the provision of more than fifteen miles of gravity roller conveyors and overhead power-driven conveyors. Conveyors are also used in carrying parts automatically through certain processes, as for example, the tinning of cylinder barrels. In addition to the reduction of manual labor in handling the work, the conveyors have completely eliminated congested areas around machines due to work in process. Fig. 1 shows an overhead conveyor carrying cylinder assemblies to Barnes honing machines, while Fig. 2 illustrates a gravity conveyor adjacent to a battery of Bullard Mult-Au-Matics that machine the cylinder barrels.

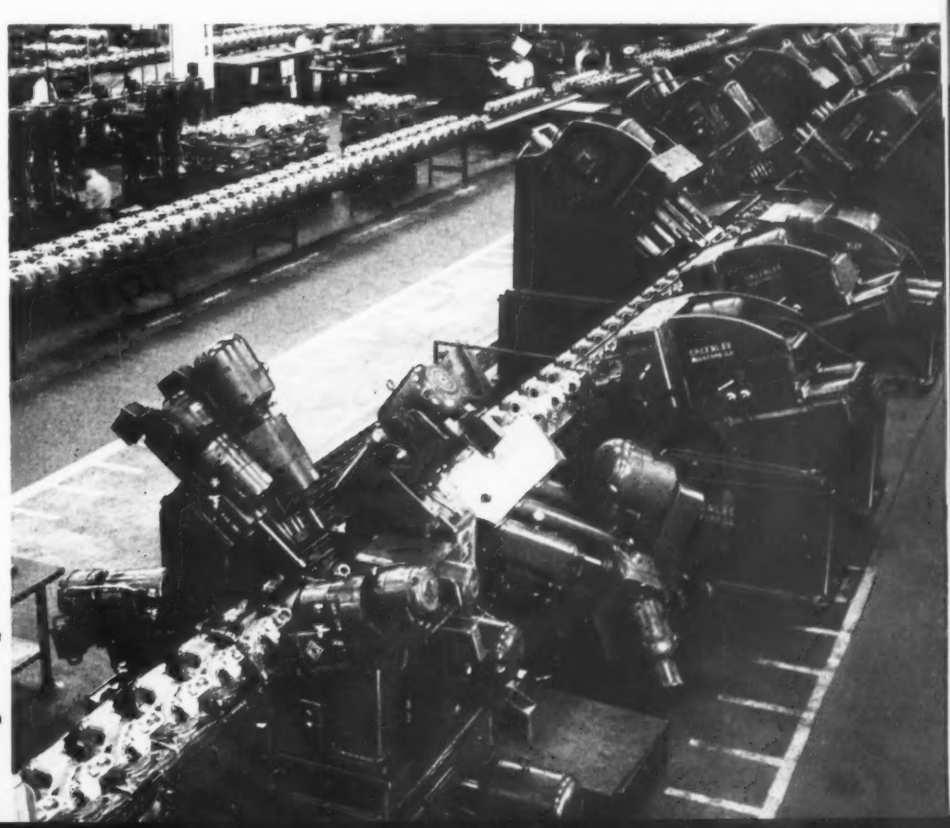

Fig. 3. Partial View of Batteries of Machine Tools Arranged in Two Groups for the Automatic Performance of Seventy-one Separate Operations on Cylinder Heads

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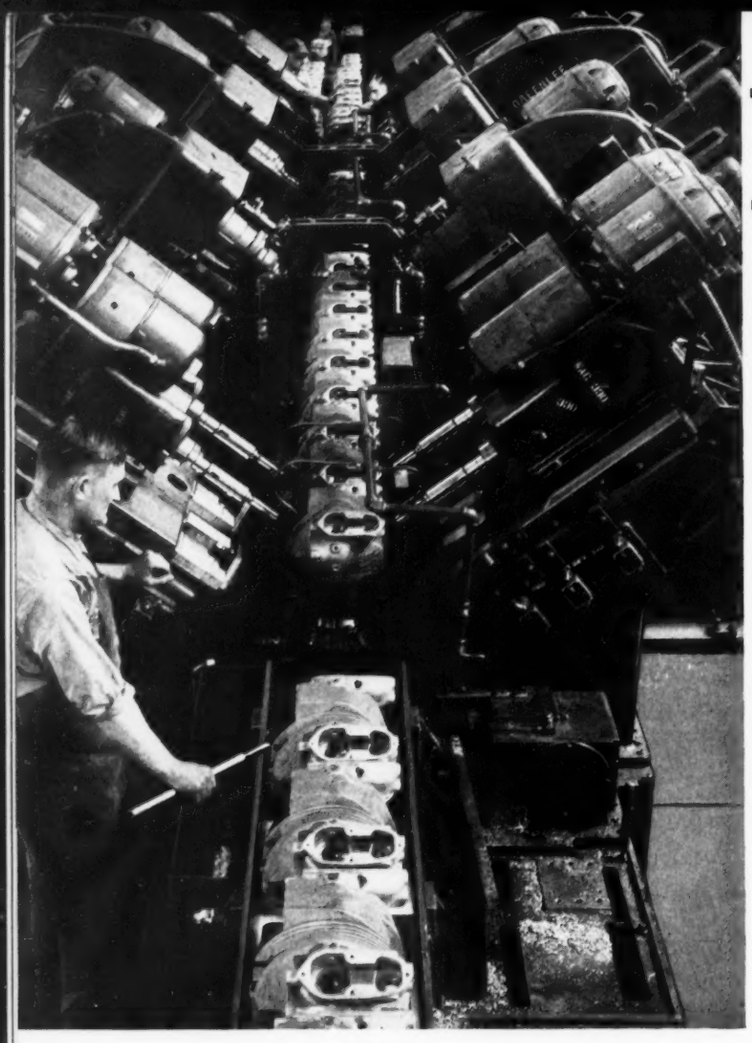


Fig. 4. Another Group of Machine Tools Coordinated into a Single Automatic Unit for Performing a Number of Operations

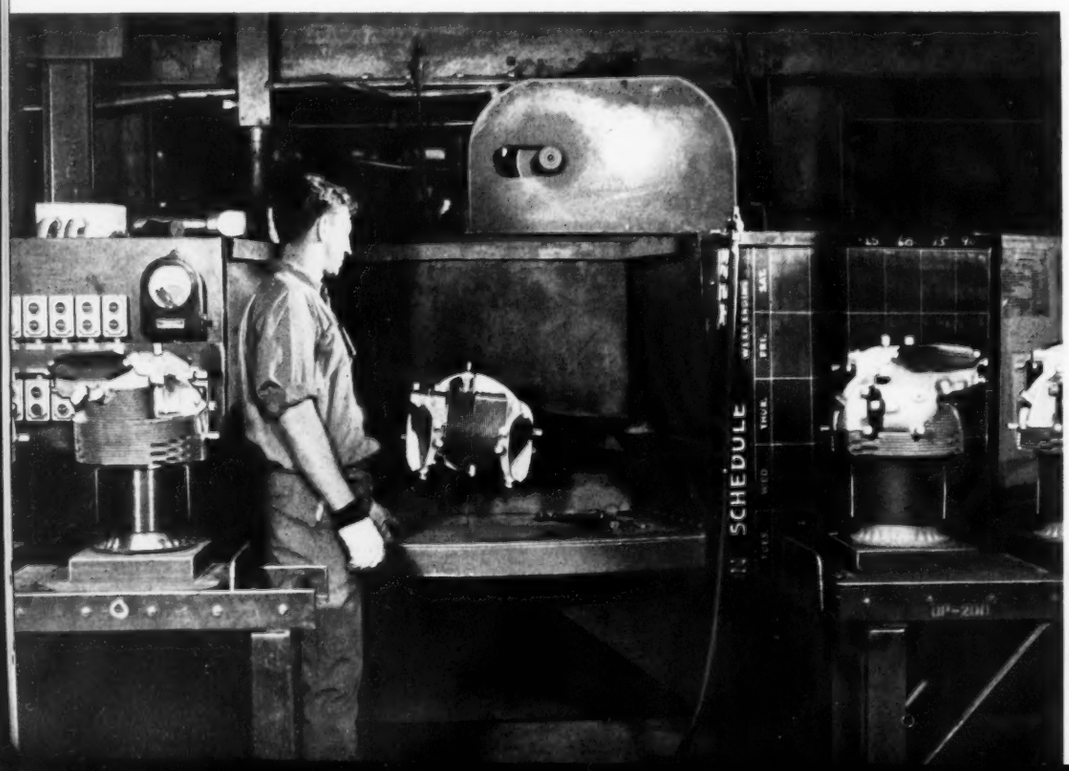
Automatic and semi-automatic machines have been installed on a scale never before known in the manufacture of airplane engines. The purpose of this has been twofold: First, to obtain an unprecedented production and, second, to enable machines to be operated by men who have been given only short intensive training courses and who could not be included in the category of skilled workers.

One set-up rivals anything that even the automobile industry has ever developed in the way of automatic machinery. It comprises a battery of machine tools arranged along a transfer table 80 feet in length. Cylinder heads mounted on square flat steel fixtures are carried automatically from station to station for complete drilling, countersinking, reaming, and tapping. They are clamped in each station, the respective operation performed, the part unclamped and moved to the next station, all automatically. A partial view of this installation is shown in Fig. 3.

The machines that make up this unusual installation are separated into two groups. The first unit has 16 stations and performs 25 separate machining operations with 64 tools. The second unit has 53 stations and performs 46 separate operations with 70 tools. Eight operators feed the cylinder-head loaded platens at the first station, and watch three control panels to see that the machine functions properly. The equipment was built by Greenlee Bros. & Co.

Another somewhat similar installation built by the same company for machining the spark-plug holes in cylinder heads after they have been

Fig. 5. Loading Station of a Large Rotary Machine Used for Carborundum-blasting the Cylinder-head Assemblies



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assembled on the barrels, is shown in Fig. 4. This equipment comprises five individual machines of duplex design which operate tool-heads from both sides of the pusher type conveyor that transfers the work from station to station. The cylinder heads are placed on steel platens also for passage through this equipment.

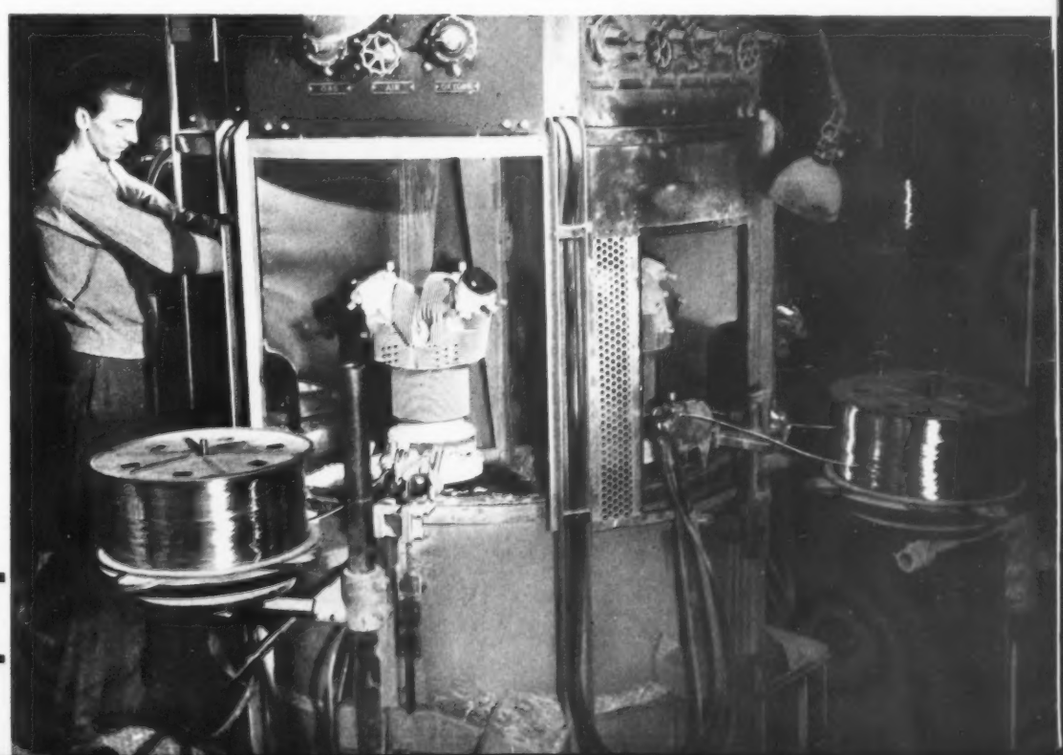
Spark-plug holes are drilled in the cylinder heads in the first station of this installation. In the second station, the spark-plug holes are rough-reamed and the angular seats around the holes are rough-countersunk. In the third station, the spark-plug holes are finish-reamed and the angular seats are finish-countersunk. These holes are rough-tapped in the fourth station and finish-tapped in the fifth station.

The assembled cylinder heads and barrels are Carborundum-blasted in a Wheelabrator provided with a large revolving unit that has eleven arms extending radially, on which the cylinder assemblies are mounted as seen in Fig. 5. As these arms move around the machine, they also revolve on their own axes and subject the cylinder assemblies to blasts of Carborundum developed by seven propeller type wheels located in various positions around the unit. The rotary unit which carries the work arms moves intermittently, so that each assembly revolves a prescribed length of time under the different blasts. The loading station is seen in Fig. 5.

The cylinder assemblies are next coated completely with aluminum as they pass from station to station around the metal-spraying machine shown in Fig. 7, which was built by the U. S.

Fig. 6. One of a Battery of Machines Used for Milling Twenty Clearance Pockets Above the Cylinder-barrel Flange

Fig. 7. Rotary Type of Machine Devised for the Automatic and Manual Spraying of Pure Aluminum on Cylinder-head Assemblies



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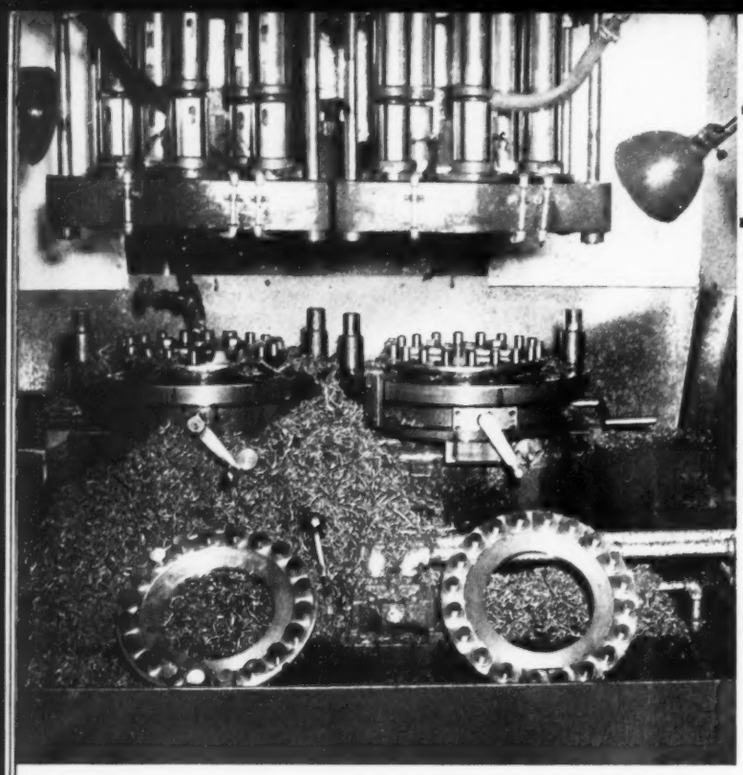

Fig. 8. Multiple-spindle Machine Equipped for Hollow-milling and Facing Twenty Trunnions on Gear Carrier Rings

Galvanizing & Plating Equipment Co. In three of the six stations, pure aluminum wire is drawn from either one or two coils and fed through an oxy-acetylene torch which melts the wire and sprays the molten metal on the cylinder head and barrel. The cylinder assemblies revolve during the operation and the torches move up and down to cover certain sections of the assemblies. The different torches are mounted at various angles so as to effectively direct metal on both sides of fins, and on other surfaces. The torch slides are actuated by individual motors.

At two stations on the opposite side of the machine from that shown, there are hand-manipulated torches to insure complete coating at places not reached by the automatic torches. The sixth station is for reloading. The cylinder assemblies do not revolve in the stations where men operate the torches, but in those stations they can be readily swiveled as required. The rotary work-table, of course, indexes periodically. This operation puts a coating of aluminum several thousandths inch thick on external surfaces to prevent corrosion from salt-water spray after the engines are mounted on planes. Before the cylinder assemblies go through this operation, plugs are inserted into various holes and covers are fastened over the intake and exhaust openings to guard against spraying the molten aluminum on internal surfaces.

The remaining operations to be described in this article involve the use of simpler types of machines designed or equipped for a single purpose. In Fig. 6 is shown one of a large battery of Moline machines, equipped with opposing tool-spindles for milling clearance pockets above all the stud holes in the cylinder-barrel flanges.

After the cylinder assembly has been loaded on the work fixture and the machine started, a large cam beneath the table, as shown, raises the barrel flange into line with the two cherrying cutters. Then the cutters are fed horizontally into the work. When the pockets have been milled to the required depth, the cutter-spindles withdraw, the work-table drops down, and the cylinder assembly indexes, ready for the next cycle. Every machine movement is actuated automatically. After nine indexings, as required

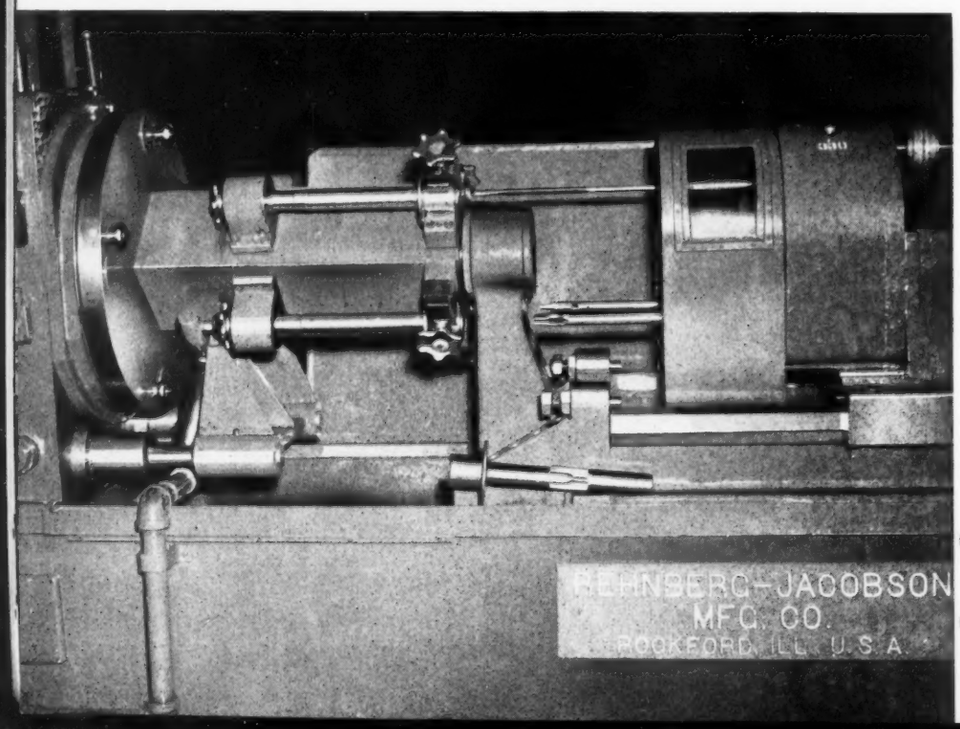

Fig. 9. Three-station Machine that Performs Straight-reaming and Form-reaming Operations in the Accessory-drive and Starter Shafts

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Fig. 10. Machine of Special Design which Mills a Groove One-third around Each Trunnion on the Gear Carrier Rings

for machining twenty pockets around the barrel flange, the machine stops for reloading.

A Rehnberg-Jacobson machine designed for an important reaming operation on accessory-drive and starter shafts is illustrated in Fig. 9. This part, which is approximately 9 inches long, is gun-drilled to two different diameters in a preceding operation. The machine shown is equipped with a four-station trunnion fixture and with a three-spindle tool-head at the right. The tool-head is traversed to and from the work by hydraulic power between automatic indexings of the fixture.

A tool on the top tool-spindle performs a reaming operation in the smaller of the two bores, which is about 6 inches long, the reamer being advanced through the larger diameter hole. The tool on the second spindle, in the lower rear position, starts reaming the larger hole to a tapered form where it joins the smaller hole. The tool on the third spindle reams the large hole for its full length and finish-forms the tapered inside end to the shape indicated by the cut-away example lying on the machine bed.

A Baush multiple-spindle drilling machine equipped with two drill heads, as shown in Fig. 8, is employed for hollow-milling and facing the twenty trunnions around gear carrier rings. When these rings reach the machine, they are of the appearance shown by the ring lying in front of the machine at the left, and when finished they appear as indicated by the right-hand example.

Each drill head has five spindles for machining a similar number of trunnions at one time as the heads are fed down. When they return upward, the fixtures are indexed by hand ready for the next down movement. Thus, it takes four down movements of a drill head to completely finish a carrier ring. The drill heads have a rapid approach to the work and then a slow feed. They are operated hydraulically. In the past, it has been the practice to perform this operation on single-spindle machines that finished only one trunnion at a time.

It is necessary to mill an oil-groove approximately one-third the way around each trunnion on the gear carrier rings. This operation is

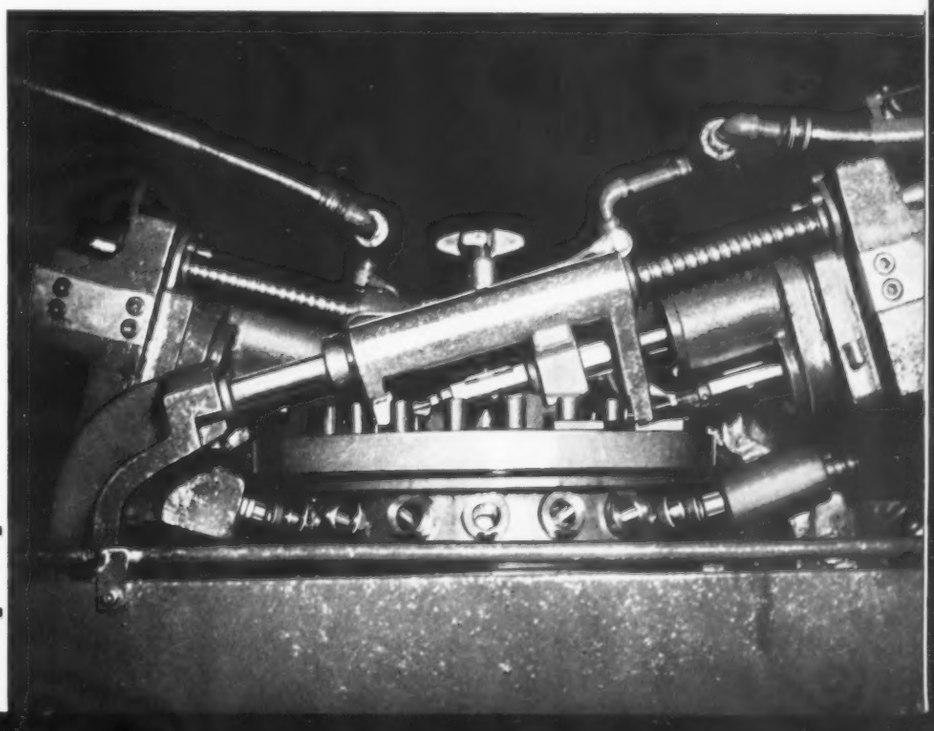

Fig. 11. Four-spindle Machine for Redrilling the Oil-holes in the Trunnions of Gear Carrier Rings after a Carburizing Operation

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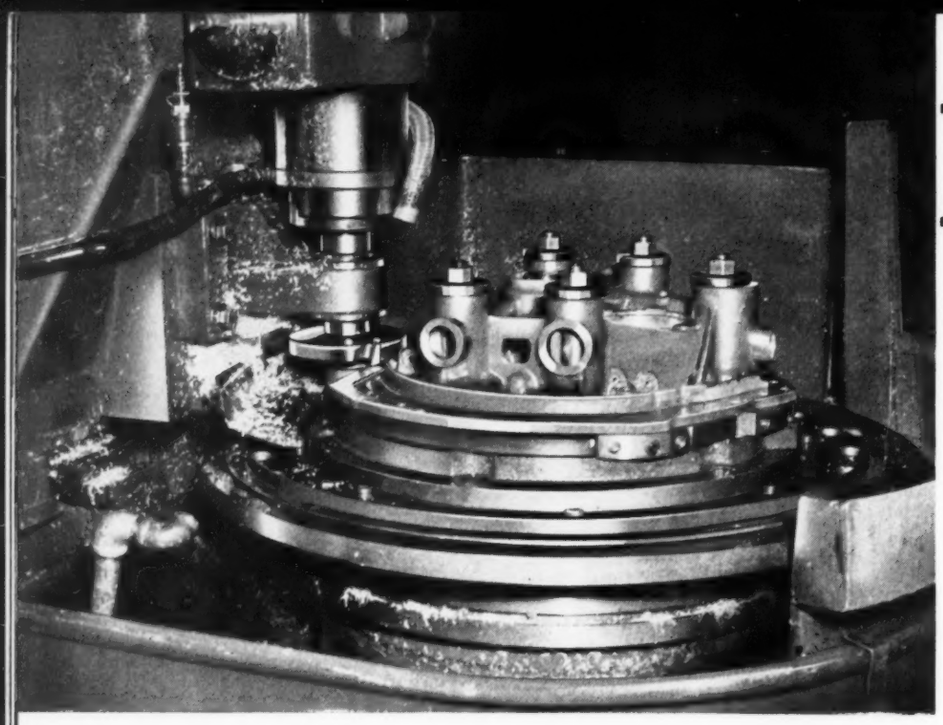

Fig. 12. Application of the Fly Cutting Principle for the Fast Flat- and Contour-milling of Magnesium Castings

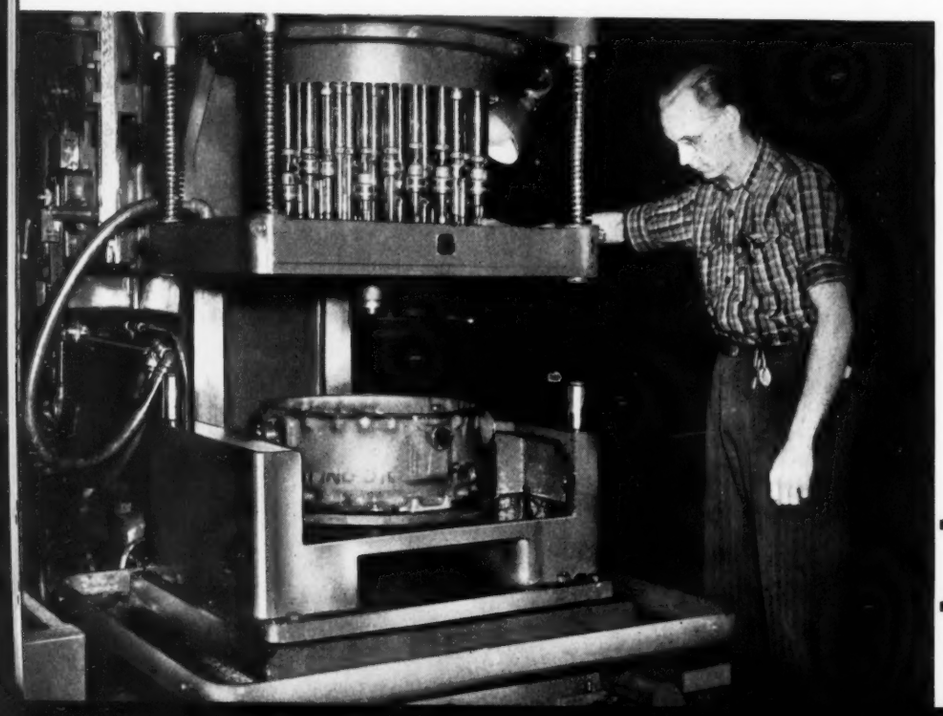

Fig. 13. Multiple-spindle Machine Tooled up for an Intensive Drilling Operation on Supercharger Rear Housings

being performed at a high production rate by LeMaire machines of the type shown in Fig. 10. As the trunnions are indexed successively to the cutter, the latter moves in a circular path around the stationary trunnion to mill the groove to the desired length and depth. This is accomplished by a combination of lengthwise and sidewise movements imparted to the cutter-head and the slide on which it is mounted. At the time that the photograph was taken, a cover had been removed from the left-hand side of the machine to expose the cam bar which governs the sidewise head movements.

A close-up view of a Snyder machine designed for redrilling oil-holes in the trunnions of the gear carrier rings to remove carbon that was deposited in the holes during a carburizing process is presented in Fig. 11. The redrilling is done before casehardening so as to avoid hardening of the hole surfaces. There are two heads on opposite sides of the machine, each of which is provided with two drill spindles. On each toolhead one of the spindles is comparatively short for drilling a hole at an angle in one of the trunnions on the near side of the gear carrier ring. The second spindle on the same head is much longer and is used to drill a hole in a trunnion on the opposite side of the ring. By the use of two heads, four holes are drilled simultaneously, in contrast to only one hole when a single-spindle drilling machine is used, as in past practice. The drills are 5/64 inch in diameter and enter the trunnions about 3/32 inch.

A Sundstrand milling machine designed for finishing the flange around supercharger rear-housing covers, and also vertical shoulders of irregular contour at several points around the part, is shown in Fig. 12. As these castings are of magnesium, the machine is designed for driving a fly cutter at 1750 R.P.M., there being

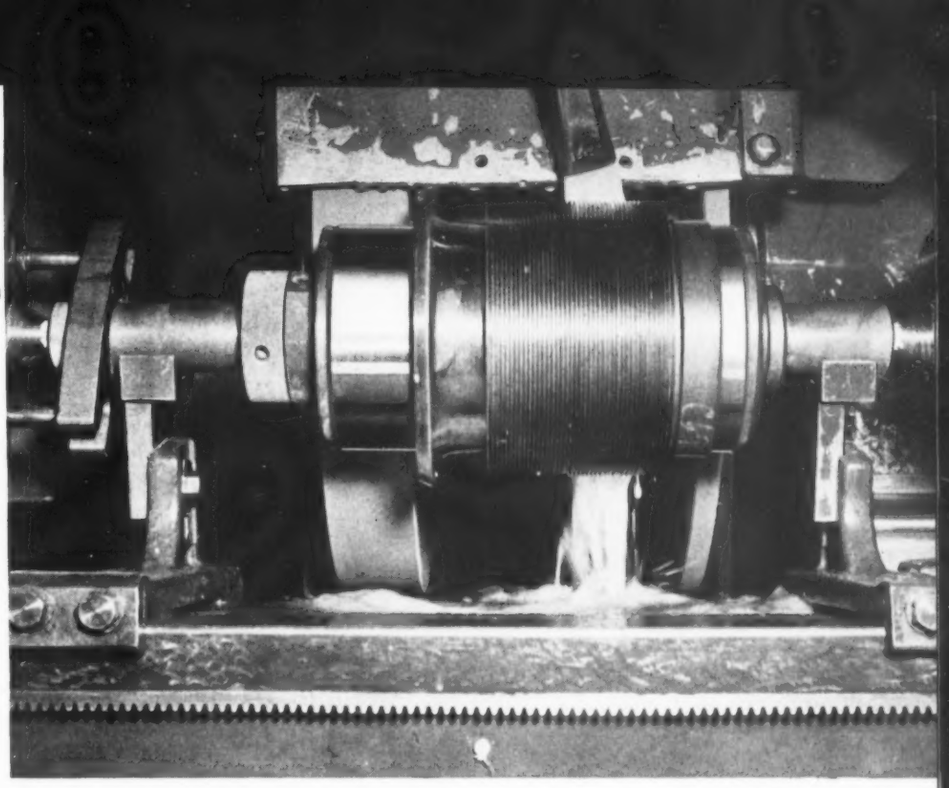

Fig. 14. Typical Cylindrical Grinding Operation on Cylinder Barrels, Two Wheels being Used Simultaneously

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a direct drive from an electric motor to the cutter-spindle.

Around the bottom of the work-table is a large ring cam that corresponds with the irregular contour of the flange on the work-piece. During an operation, hydraulic pressure holds a roller attached to the bottom front of the cutter-slide against this cam. Consequently, as the work-table revolves, the cutter-slide and cutter are moved back and forth to suit the changing work contour. The width of the flange varies up to 1 3/4 inches and the vertical shoulder up to 3/4 inch in height.

There are two cutters of tungsten carbide on the cutter-head and they produce an exceptionally fine finish, at the same time machining the flange to the specified thickness within 0.002 inch all around the casting. They remove stock to a depth of about 3/16 inch.

Seventy-four holes are drilled in the supercharger rear-housing cover and 57 are reamed by two Hydram multiple-spindle drilling machines such as shown in Fig. 13, although this illustration shows a machine set up for a drilling operation on the housing itself. In this operation 27 holes are drilled. They are reamed on another machine of the same type.

These machines are equipped with a table that is moved forward by hydraulic power into the reloading position and similarly returned to the working position. With this arrangement the drill head need not be raised to the height that would otherwise be required to enable reloading the work. The drilled and reamed holes are held to within plus or minus 0.0005 inch of specified center distances.

Many grinding operations are necessary, of course, in finishing the external and internal surfaces of the cylinder barrels. Fig. 14 shows how two operations have been combined into one

Fig. 15. Automatic Machine that Assembles Ball Ends into Rocker-arm Push-rods at a Fast Rate

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by the use of a Norton cylindrical grinding machine equipped with two wheels. Plunge cuts are taken and then the piece is moved sidewise to enable the flange face to be finished by the larger of the two wheels. The diameters are held to within 0.001 inch of specified dimensions.

A Snyder machine devised for rapidly assembling ball ends into rocker-arm push-rods is shown in Fig. 15. The rods are loaded into a vertical magazine as illustrated and the ball ends are loaded into slots at both ends of the magazine. The ball ends have spherical heads, and shanks 3/8 inch diameter by 3/4 inch long.

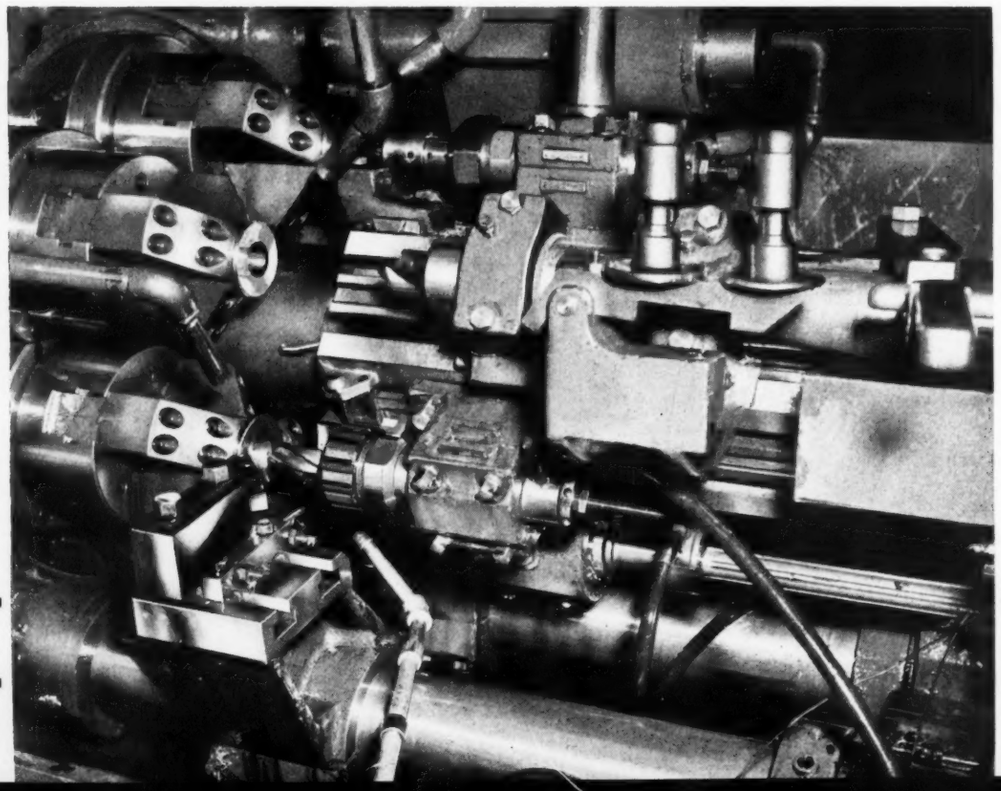
On both sides of the magazine there is a hydraulically operated slide with two flat-end cylindrical tools in a horizontal plane. As each rod falls down on supports that hold it in the assembling position, the slides advance and push the shanks of two ball ends into the opposite ends of the push-rod for a distance of about 1/4 inch. Then the push-rod rolls back into a second position, where the back tools on the slides operate to push the ball-end shanks the full distance into the rods. After the first rod has been carried to the second position, there are, of course, rods always in both the first and second positions so that one assembly is obtained with each operation of the machine. The assembled push-rods roll down a chute at the back of the machine.

Of the many multiple-spindle automatic screw-machine operations in the plant, the one shown in Fig. 16 may be considered typical. It consists of machining the hole in magneto drive-shafts on a New Britain-Gridley after the part has been turned in a similar machine.

The first step in the operation shown consists of spot-facing the end of the part. Then tools in the next station of the tool-slide drill about one-half the length of the part, face the end, and turn the flange. In the third station, a smaller diameter drill is fed the full length of the part. The part is counterbored and chamfered in the fourth station. The large diameter hole is reamed and the end of the piece is finish-faced in the fifth station. Finally, the smaller hole is reamed in the sixth station and the large hole is chamfered.

It is possible to describe only a comparatively few operations in an article. There are, of course, thousands of others that are of interest, although many of them have become standard practice during recent years, particularly such operations as the machining of cylinder barrels, pistons, master and articulated rods, and crankcases. It is of interest to note that on one engine of the type here discussed there are approximately 800 different kinds of parts and about 8750 parts all together.

Fig. 16. One of a Large Battery of Automatics which Performs a Second Operation on Magneto Drive-shafts



LOCKHEED P-38 "LIGHTNING" INTERCEPTOR WITH ALLISON ENGINES AND CURTISS ELECTRIC PROPELLERS

Plastic Tooling Speeds Up Lockheed and Vega Production

By CHARLES O. HERB

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Fig. 1. Pouring Hot Liquid Phenol-acetone Resin into a Plaster Mold to Produce a Plastic Drill Jig. The Inventor of the Process, M. D. Basolo, of the Lockheed Aircraft Corporation, Stands at the Right

Fig. 2. Ivan Hicks, Carl L. Hill, and John McCauley, who were Mainly Responsible for the Development of Plastic Tools in the Vega Plant, are Seen Discussing Several Different Types of Plastic Drill Jigs

Plastic Tooling at Lockheed and Vega

Jigs, Routing Forms, and Even Forming Dies Now being Made of Plastic Materials—One of the Recent Developments in the Aircraft Industry

By CHARLES O. HERB

ENGINEERS of the aircraft industry have always shown remarkable ingenuity in developing new production methods and processes to meet the specific needs of their industry. One of the outstanding developments of this classification during the last year has been made by engineers of the Lockheed Aircraft Corporation and its affiliated company, the Vega Airplane Co. This development is the application of plastic materials to expedite the production of the many drill jigs, routing forms, and templets required in airplane manufacture. Even forming dies made from plastics for use on hydraulic presses have given satisfactory performance.

The use of plastics for drill jigs was conceived by M. D. Basolo, foreman of the Lockheed jig and fixture shop, who holds a patent for this application. Mr. Basolo is seen at the right in Fig. 1, watching hot liquid phenol-acetone thermoplastic being poured into a plaster mold for a wing-root fairing drill jig. Vega engineers who later also applied the process to drill jigs in their plant, and who have extended the idea to routing and other forms, and dies for use on hydraulic presses, are Ivan Hicks, wood shop foreman, and Carl L. Hill and John McCauley of the plastic tool development group. These men appear in that order in Fig. 2, discussing typical plastic drill jigs.

To illustrate the importance of this development, it may be mentioned that jigs, forms, and dies which formerly took a couple of weeks to make can now be produced in plastics within approximately four hours, two of which are required for baking the material. In the first application of plastic tools, three months' tooling time was saved in preparing for the building of large bombing planes in the Vega plant.

More than 200 plastic tools were made at the Vega plant within a period of two months. Some of these tools required as much as 38 gallons of plastic material and in finished form weighed as much as 380 pounds. These heavy plastic tools were forms for use in sheet-metal stretching operations and they replaced zinc-alloy forms. They will last long enough to turn out all work-pieces required under the present airplane contract. Plastic tools are light in weight, and so they can be more conveniently handled than metal or wooden jigs. Zinc forms or dies, for example, weigh seven times as much as similar tools made of plastic. If a plastic jig or form should be broken accidentally, it can be replaced with little loss of time and with negligible cost. The plastic materials can be ground up as tools become obsolete and used over and over again.

Plans have been completed for electroplating plastic die sets with copper and chromium in order to increase their life. While most plastic die sets have been used for forming operations, dies of this material have proved satisfactory even in punching holes in aluminum-alloy sheets. Six thousand parts have been produced with one plastic die set under a hydraulic press without any noticeable wear on the tools.

Fig. 3 shows a typical plastic forming die on a large hydraulic press. The operator is about to place a loose plastic member backed up by a sheet of Masonite on top of the duralumin sheet to be formed. Rubber pads on the press ram will force the loose die member down to press the work-piece into the shape illustrated in Fig. 5. These photographs were taken in the Vega plant where all plastic tools are made from an acid-setting phenol formaldehyde, which is a thermosetting composition. This plastic is poured cold and baked in a cookie oven, whereas the plastic used in the Lockheed plant is poured hot and allowed to cool in the molds.

The application of plastic materials for the purposes outlined resulted from an investigation conducted to find a substitute for the wooden

Fig. 3. Thermosetting Plastic Die being Employed for a Forming Operation under a Big Hydraulic Press

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drill jigs that are in wide use throughout the aircraft industry. The Basolo patent is based on the production of plastic jigs by employing a master part (an actual piece of work) to which drill bushings are secured wherever holes have been drilled. This master part is placed in a wooden form and the plastic material is poured into the cavity. When the plastic material has solidified in conformity to the contour of the part, either by natural or by artificial means such as baking, the bolts which hold the bushings in position on the master part are removed. The jig is then practically ready for use. Obviously, such a method of producing jigs holds distinct advantages over the use of wooden jigs, in which a three-dimensional cavity, shaped to the contour of the work, must be produced by laborious means.

The simplicity of this method of drill jig production will be apparent from the diagrams in Fig. 4, which show a mold constructed of wood and the duralumin stamping for which the jig is intended. The piece of work *A* will form the bottom of the drill plate that is to be cast, with

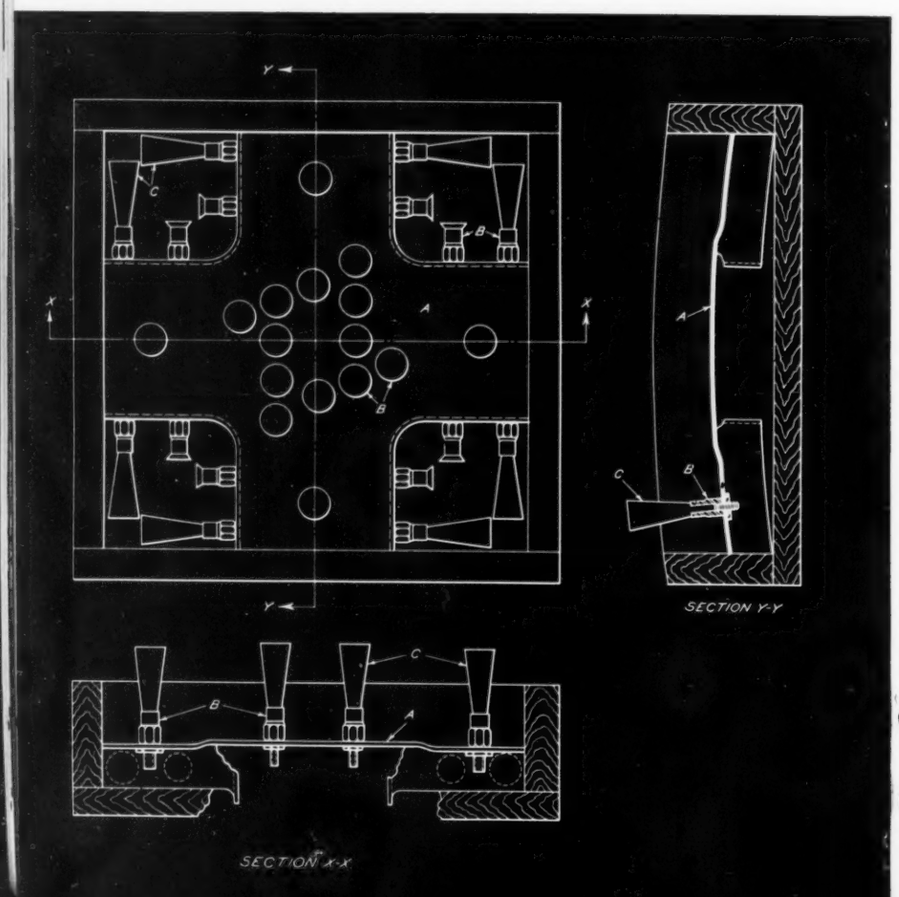

Fig. 4. Diagram Showing the Construction of a Mold for Casting a Drill Plate with the Drill Bushings Fastened to the Work-piece

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Fig. 5. Appearance of the Duralumin Sheet-metal Part Produced in the Operation Illustrated in Fig. 3

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the drill bushings accurately held in their required locations. The opposite side of the work-piece will form the cavity in the nest block of the jig. It will be seen that the drill bushings *B* are fastened to the work-piece by means of special screw plugs *C*, which can be readily withdrawn through the plastic drill plate after the plastic material has solidified. The mold was built up with thirty-two bushings.

The construction of the complete jig is shown in Fig. 6. It consists of a wooden box in which the plastic nest block *D*, which was also poured in the mold shown in Fig. 4, is permanently secured. Drill plate *E* is removed for loading successive pieces of work *A*. The drill plate is clamped on top by means of wood blocks *F*, which are fastened through the use of bolts and wing-nuts.

An alternate method from that shown in Fig. 4 of fastening drill bushings to the piece of work in casting the plastic mold, is to use a loose tapered plug on top of the drill bushing and attach it to the bushing by means of a flat-head bolt. The bolt is used with the head on the bottom or inner side of the bushing and the nut is on top of the tapered plug.

At the Vega plant the method of casting drill jigs differs substantially in that the bushings are never cast directly in the plastic. The practice is to cast the bushing plate blank and then drill holes in the bushing plate in the correct locations as determined from the work-piece, locate the drill bushings accurately in these holes, and then set them in Cerromatrix. In pouring Cerromatrix, the user must make certain that it is not too hot or it will expand and crack the plastic. A temperature of approximately 300 degrees F. is the proper one for pouring operations.

Before the selection of a material suitable for

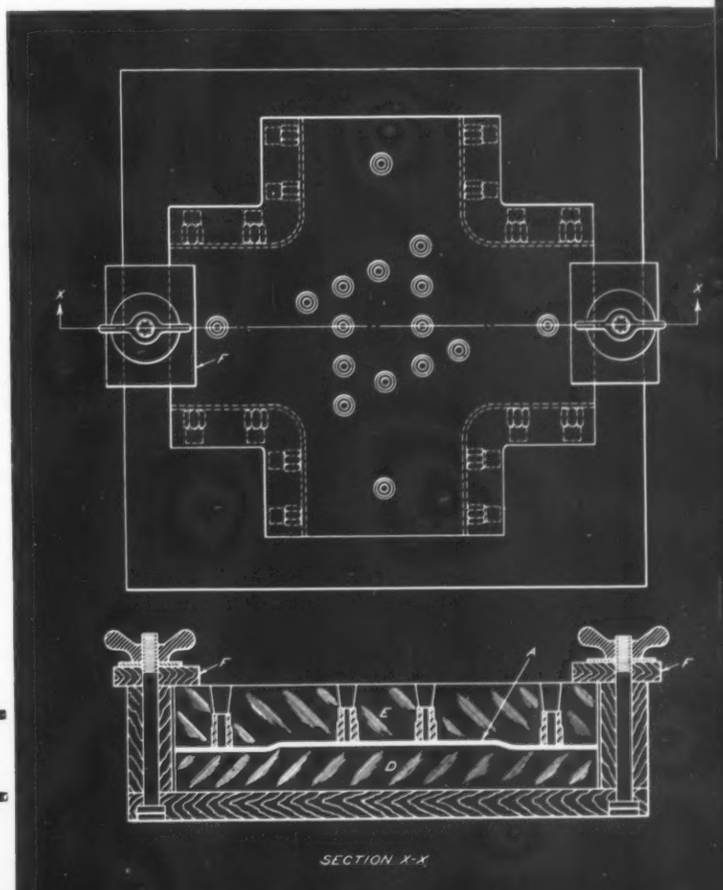

Fig. 6. Construction of a Simple Drill Jig, in which the Plastic Nest Block and Drill Plate are Assembled in a Wooden Box

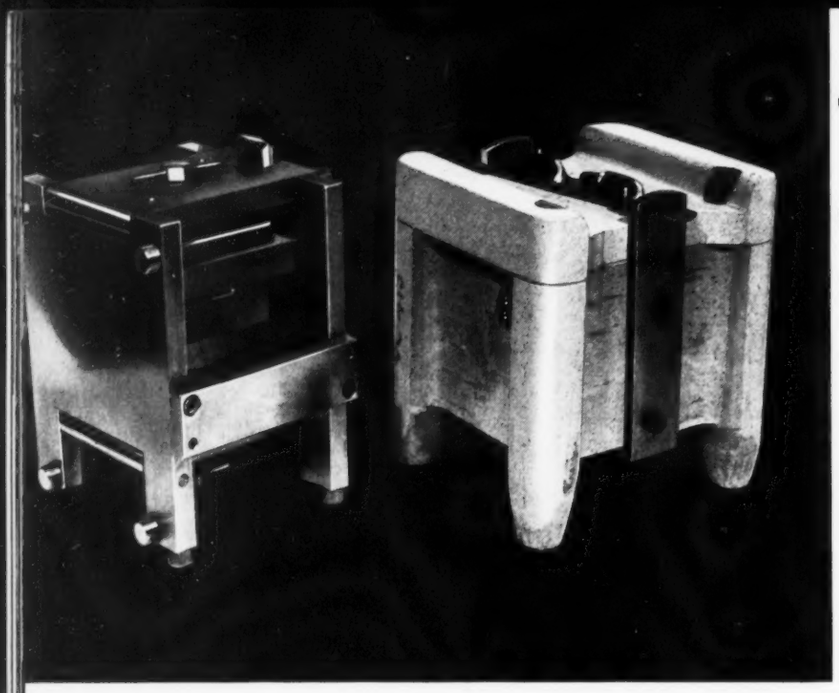

Fig. 7. (Left) Plastic Drill Jig, at the Right, and the Steel Jig, at the Left, which It has Replaced at a Great Saving in Cost and Production Time

Fig. 8. (Below) Several Plastic Drill Jigs Designed for Handling Sheet-metal Parts Similar to that Seen being Lifted from the Jig

the production of drill jigs by the methods described, Lockheed's research department conducted an investigation with a considerable variety of materials to determine the most satisfactory one. In addition to plastic materials, experiments were conducted with plaster and some of the white metals of low melting point. It was finally concluded that the ideal material for this process would be a plastic that could be poured at between 225 and 325 degrees F. and which would have a minimum softening point of 200 degrees F. These requirements make it possible to pour a plastic jig or other plastic tool in an aluminum-alloy part without damage to the latter and insure that the plastic material will not soften due to the heat generated in drilling or other operations. This is the method still in use at the Lockheed plant, although, as already mentioned, the practice at the Vega plant is to use a plastic composition that is poured cold and then baked.

Other desirable characteristics indicated by the investigation, which have been found attainable, were that the plastic materials to be used for this purpose should be easily reclaimable, that it should be possible to machine the plastic tools with woodworking tools, that the plastic materials should have sufficient impact strength to withstand ordinary shop handling, that they should not exhibit brittleness at low temperatures or after aging, and that they should be resistant to oil and metal chips.

The result of the investigation was the adoption of a thermoplastic phenol-acetone resin at the Lockheed plant and an acid-setting phenol formaldehyde at the Vega plant. The phenol acetone is used without a filler and has an ultimate compressive strength of 6000 pounds per

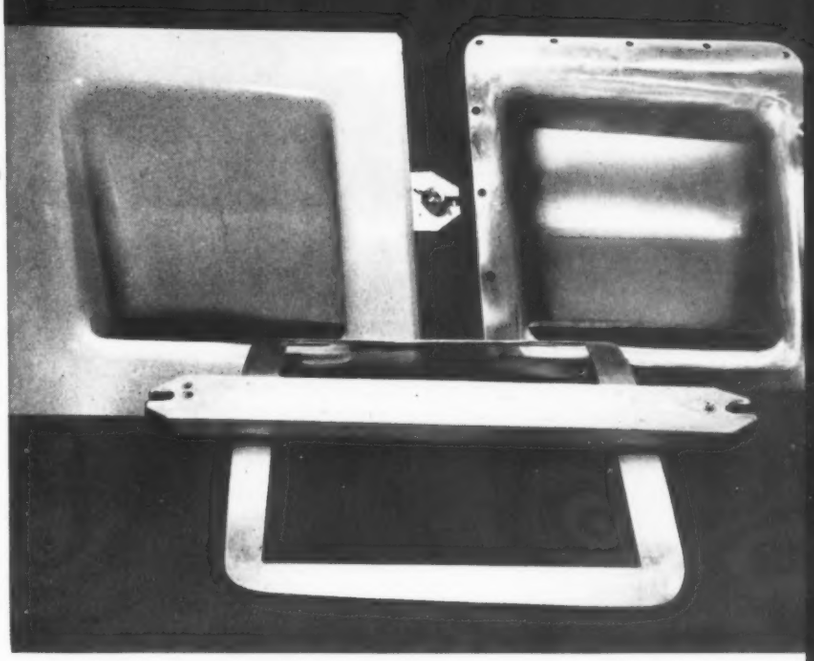

Fig. 9. (Right) Plastic Templet, at the Left, which is Used in Hammering out the Wrinkles of Aluminum Air Scoops Such as Seen at the Right

Fig. 10. (Below) Drill Jig for Junction Boxes of a Type which has been Made in a Large Range of Sizes, Together with the Mold

square inch. It is fairly tough and with the addition of 1/2 per cent Maracaibo wax shows satisfactory resistance to soluble oil. Walnut shell flour, fine maple wood, and ground Masonite are used as a filler with the phenol formaldehyde resin. This material has an ultimate compressive strength of over 8000 pounds per square inch and, therefore, can be satisfactorily applied in deep drawing operations on hydro-presses. It is resistant to soluble oil without any special treatment. It is, however, fairly brittle.

At first Maracaibo wax to the extent of 3 per cent was used in making the phenol-acetone material resistant to oil, but undesirable aging soon became apparent. The aging, however, appeared to be due to crystallization of the excess Maracaibo wax and so the problem was solved by reducing the quantity of wax used for oil resisting purposes. This has not adversely affected the resistance of plastic drill jigs to soluble oil.

The phenol-acetone plastic was developed for aircraft tooling. It is a phenol-ketone condensation product, which means that phenol and acetone react in the presence of an acid catalyst under heat and pressure to polymerize into a fusible thermoplastic resin that will remain thermoplastic regardless of the temperatures to which it is submitted. For use in aircraft tooling applications the plastic is modified with certain compounds of plasticizers and waxes to give the desired properties.

This composition has a cold flow point of 170 degrees F. if held for two hours at that temperature and, therefore, a shop temperature of 100 degrees F. has no tendency to make the material cold-flow. A desirable property of the material is very low heat conductivity.

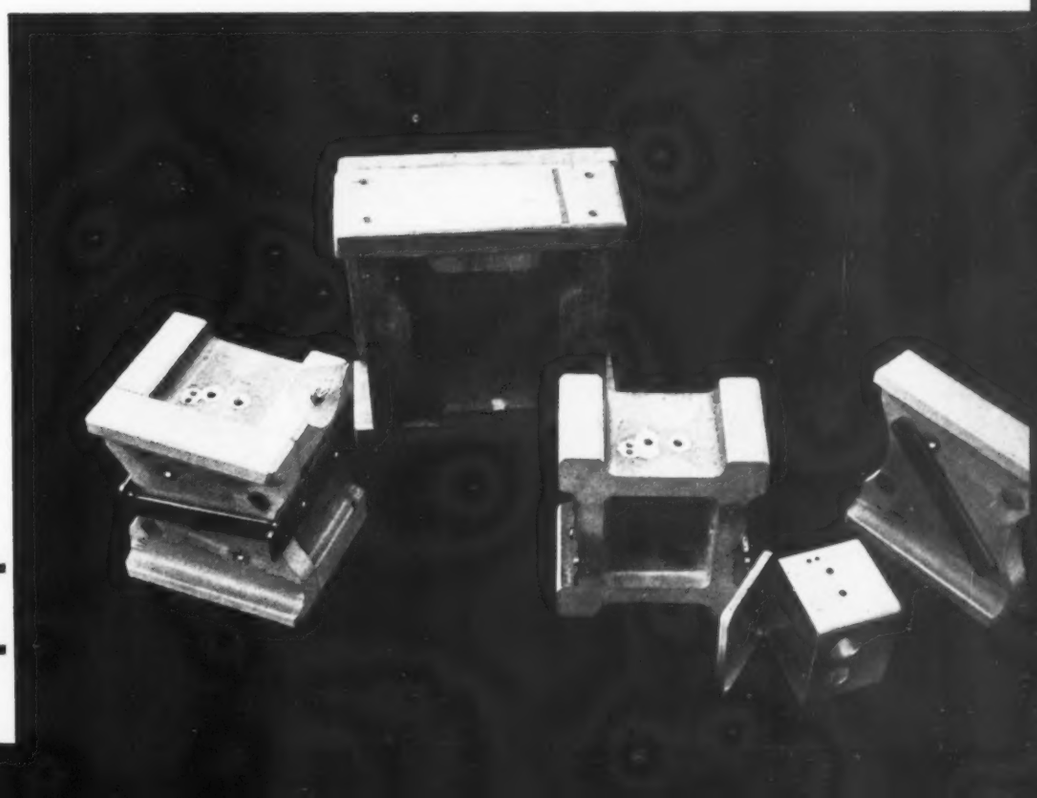

Fig. 11. Combination Drill Jig and Routing Templet in which the Drill Bushings are Held in Metal Strips Mounted on a Plastic Form of the Required Contour

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The advantage of the cast phenolic resin used at the Vega plant is that it is a thermosetting compound with an acid catalyst or accelerator which hastens the reaction in polymerization. This means that the liquid resin is inhibited with an amount of acid which, through the application of heat, will set it up within approximately two hours. The less acid that is used to set up a resin, the less crystalline formation there will be in the finished product and therefore the stronger the plastic tool.

If the baking process is performed at a temperature of approximately 175 degrees F., it is possible to use a resin with less acid and obtain relatively less crystalline structure in the finished product. From 25 to 30 per cent filler material is mixed in the resin used at the Vega plant, which materially reduces the tool costs.

Reference has been made to the fact that the plastic tools are broken readily if dropped. For this reason some of the plastic tools, such as routing blocks, are mounted on Masonite sheets. Such bases can be applied to the plastic form by using the same resin, but with additional acid supplied to quicken the reaction.

Regardless of whether the mold is constructed of wood, plaster, or metal, it should be sprayed with lacquer to protect it from the acid used in the resin. Likewise, all metal inserts in the mold, such as bushings or pins, should be lacquer sprayed. If sanding is necessary after a plastic tool has been made, the sanded sections should also be sprayed. There is a plastic lacquer available for this purpose which has a high tensile strength and which will not scratch under normal usage. If Barbary wax is later applied on

Fig. 12. Large Plaster Mock-ups from which Dies were Made for Forming Heated Sheets of Plexiglas to the Required Shapes

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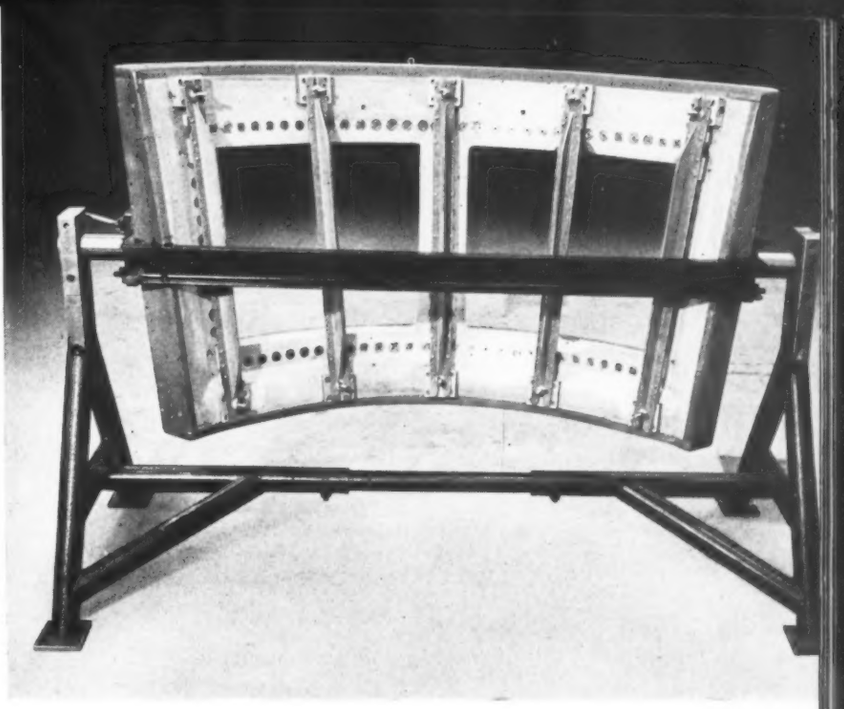

Fig. 13. Trunnion Type of Jig Built up of Mahogany and Plastic Material for Drilling through Skin, Channel Members, and Plexiglas of Pilot Escape Hatches

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the lacquer, a hard high-gloss finish is obtained, which will stand compressive loads and light oils can be used as lubricants in the drawing operations.

In making a plastic tool, the greatest saving in time is due to the fact that an actual piece of work, as it comes from the drop-hammer or hydraulic press, can be used as part of the mold to form the depression in the plastic material in which the piece of work will be seated when the tool is placed in use.

At the left in Fig. 7 is shown a jig of steel construction which took ninety hours to make in the tool-room, and at the right, a plastic jig that replaced the steel jig. The total time involved in making the necessary mold, pouring the plastic material, and baking the plastic required only two days. One of the incidental advantages of this jig, in addition to economy and speed of production, is that it can be loaded in half the time that was required with the steel jig.

Sixty-five drill jigs of the type seen at the extreme left in Fig. 10 are in use at the Vega plant for drilling operations on duralumin junction boxes ranging in size from 3 to 24 inches square. At the right a similar jig is shown with the top drill plate disassembled and with a drilled junction box lying in front. A box of this type was actually used to form the cavity in the jig during the pouring and baking of the plastic. In the background of Fig. 10 is seen the wooden mold used for the jig.

At the left in Fig. 9 is seen a plastic form used in smoothing out the wrinkles of aluminum-alloy air scoops of the type seen at the right.

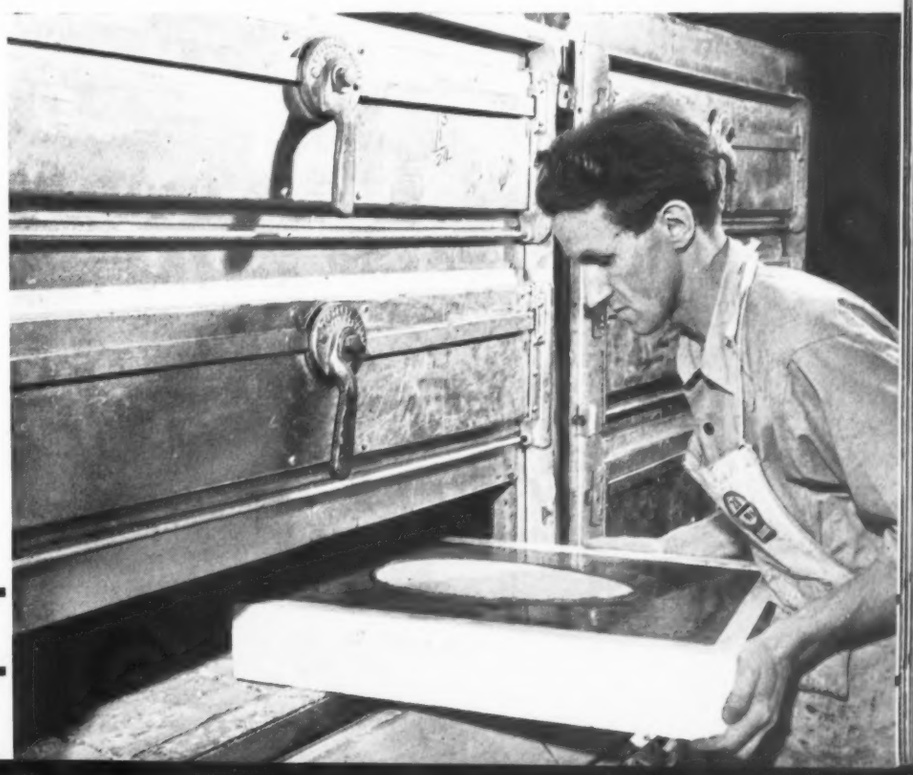

Fig. 14. Plastic Tools Made at the Vega Plant are Cured in This Oven at a Temperature of 175 Degrees F. for Periods of Two to Eight Hours

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Fig. 15. Plastic Jig or Die Members are Removed from the Plaster Molds at the Vega Plant by Using Compressed Air to Produce an Ejecting Action against the Back of the Mold

This smoothing operation is performed with rubber mallets after the air scoops have been shaped on drop-hammers. In the foreground of the illustration is seen a clamp that is employed for holding the work to the plastic form during the smoothing-out operation.

In Fig. 11 is shown a combination drill jig and routing templet that is used in the performance of operations on formed angles for supercharger pans, such as seen above and below the jig. The drill bushings were assembled in Cerromatrix in "overpressed" sheet-metal templets which were made over pieces of work in hydro-press dies. These sheet-metal templets were drilled to diameters larger than the normal holes, so as to enable larger bushings of Cerromatrix to be cast around the drill bushings for holding them securely in place. The construction of this combined drill jig and routing templet consists of a large plastic form mounted on wood built up in sections to the required shape.

A trunnion type of jig designed for simultaneously drilling through the skin, channel members, and Plexiglas of pilot escape hatches is illustrated in Fig. 13. The jig proper consists of a cast plastic member in which a large number of drill bushings are assembled, again in Cerromatrix. This plastic member is mounted in a frame of built up mahogany. The workpieces to be drilled are fastened on the under side of the jig, which is that illustrated, by

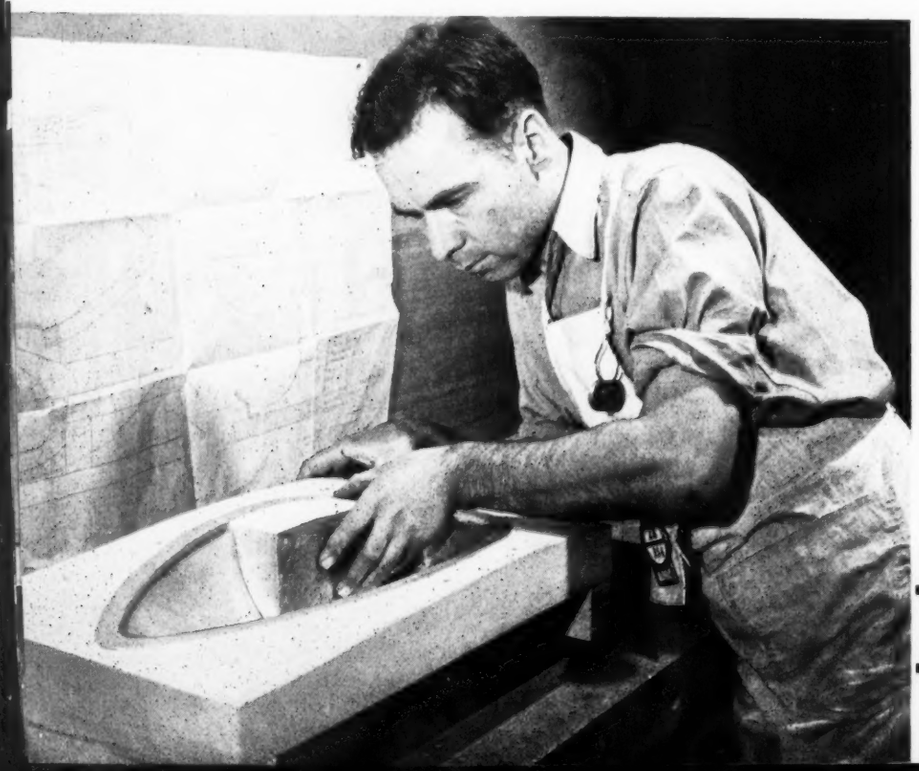

Fig. 16. Fitting a Plastic Clamp on a Dished Sheet-metal Part that will be Held in the Plastic Routing Block Seen to Facilitate Routing Operations

means of T-iron straps. An interesting feature of this jig is that the plastic was poured directly in the mahogany frame with a piece of work giving the desired contour to the inside of the plastic form. The mahogany box went into the baking oven with the plastic material. The drill bushings were later assembled in locations determined from drill bushings actually mounted on a skin, channel, and Plexiglas assembly.

Two of the largest plastic forms to be built as yet were produced from the plaster mock-ups shown in Fig. 12. The dies are to be used in forming Plexiglas windows. The heated Plexiglas sheets will be formed to shape by mounting them on one plastic member and then pressing another plastic form over the Plexiglas sheets. Blocks of wax placed around the mock-up for the internal form gave the right dimensions for the inside of the external form.

Comparatively little equipment is required for the production of plastic tools, as the molds can be readily made. At the Vega plant, a dough mixer converted to meet requirements is used to mix the resin and filler. In Fig. 17 a mixture is being poured from the machine into a mold for a router block. Within three hours the router block will be in use in the shop.

The cookie oven used in curing the plastic tools at the Vega plant is shown in Fig. 14. Depending upon their size, plastic molds remain in this oven for from two to eight hours. When the plastic tools have been thoroughly baked, they are removed from the molds by applying compressed air, as shown in the illustration Fig. 15. The lacquer on the plaster mold prevents the plastic from sticking to the mold.

Fig. 17. Pouring Plastic Resin from a Converted Dough Mixer into a Plaster Mold to Produce a Plastic Router Block, which was in Use within Three Hours after the Mold was Poured

In Fig. 16 a plastic form for holding a dished duralumin part in a routing operation is being fitted with a plastic clamp in the tool shop. It is in this department that clamps, guides, bushings, and other details are applied to plastic tools to prepare them for shop use.

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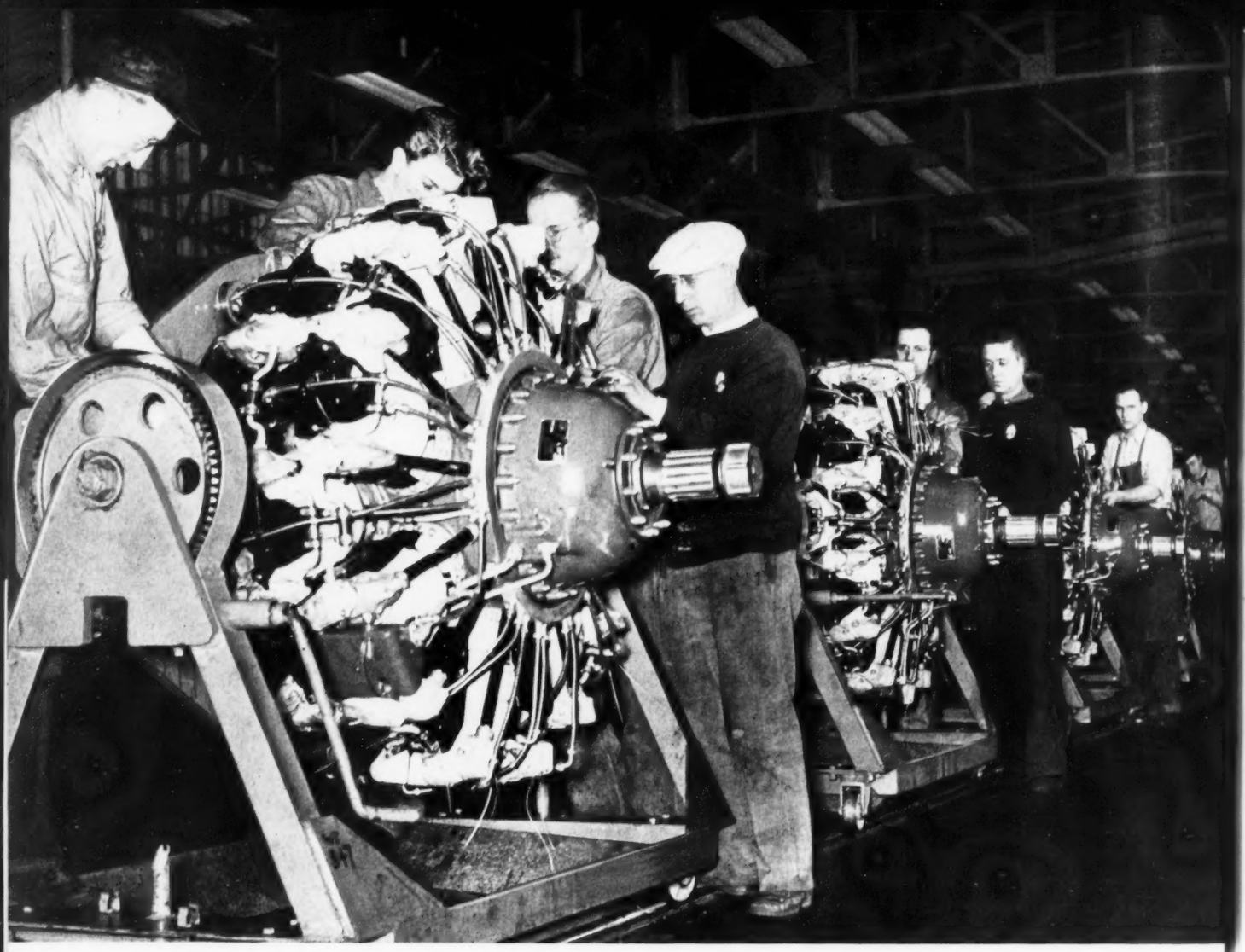


Fig. 1. The Buick Motor Division of the General Motors Corporation Turns to the Building of Airplane Engines to Help Attain a Victory that will Again Permit the Wide Use of Its Peacetime Products. Pratt & Whitney Radial Type Engines are Seen in This Illustration Rolling down an Assembly Line in a Buick Plant that was Built and Placed in Operation in Record Time

Buick Now Manufactures Bomber Engines

By CHARLES O. HERB

THE reputation for progressive thought and action earned by the engineers and production men of the automotive industry during past years is being maintained as these men devote their energies toward producing weapons that will win the war. In line with the traditions of the automotive industry, Buick personnel, within eight months, transformed a cornfield into a complete plant for turning out Pratt & Whitney twin-row, fourteen-cylinder, radial aircraft engines of 1200 H.P. Engine parts were in production within two hundred days after the blueprints had been completed for the plant, and complete engines were being turned out in another forty-three days.

This engine plant has exceeded original production schedules many times. The production in April of this year, for example, was considerably greater than had been planned for April, 1943, under schedules established last summer. Typical production operations in the Buick aviation engine plant, which is considered one of the most efficient in the entire country, will be described in this article. The engines weigh approximately 1500 pounds.

About 60 per cent of the parts used in assembling these engines are produced either at another Buick plant or by sub-contractors and shipped to this plant for assembly. Numerous other parts are manufactured here. Production lines are arranged for a continuous flow of work from raw materials storage to inspection benches and then to an assembly line which turns out engines at a gratifying rate of speed, the exact number, of course, being a military secret.

A section of this assembly line is shown in Fig. 1. The engines are assembled on carriages which are provided with a trunnion, so that the engines can be turned through 180 degrees for convenient assembly with the engine in either vertical or horizontal positions. The carriages are pushed from one end of the assembly line to the other. As the engines leave the assembly line, they are weighed on a floor type Toledo scale, as shown in Fig. 4, while still on the carriage on which they were assembled. The engines are then sent to testing rooms for complete performance tests. While it used to take from three to six hours to set up one of these engines for the tests, Buick engineers have de-

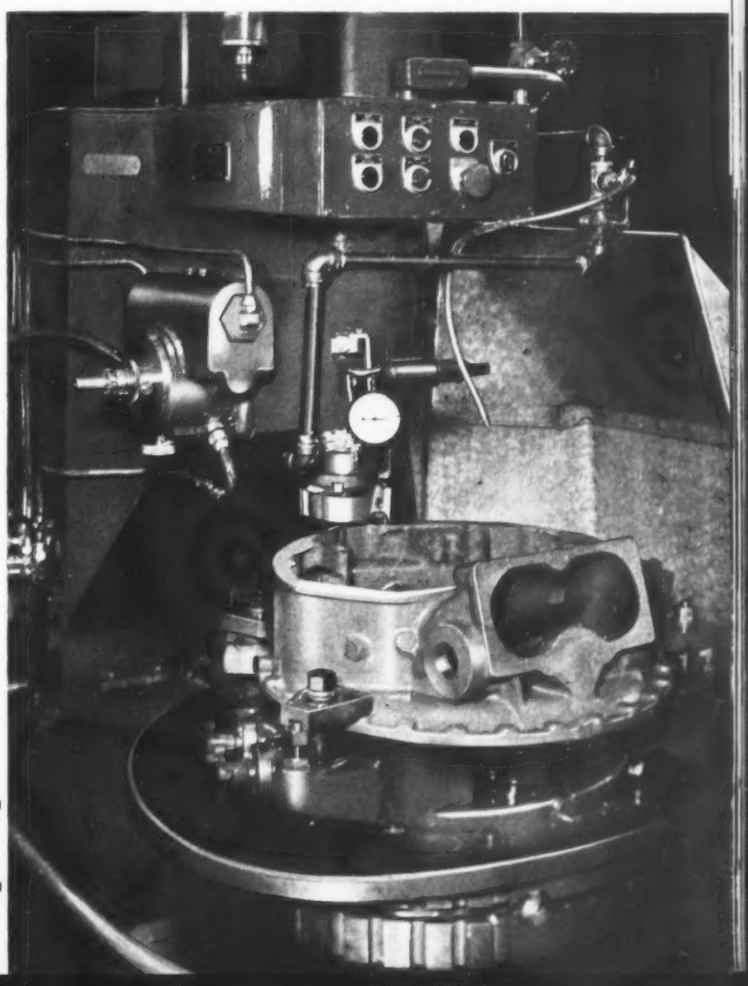
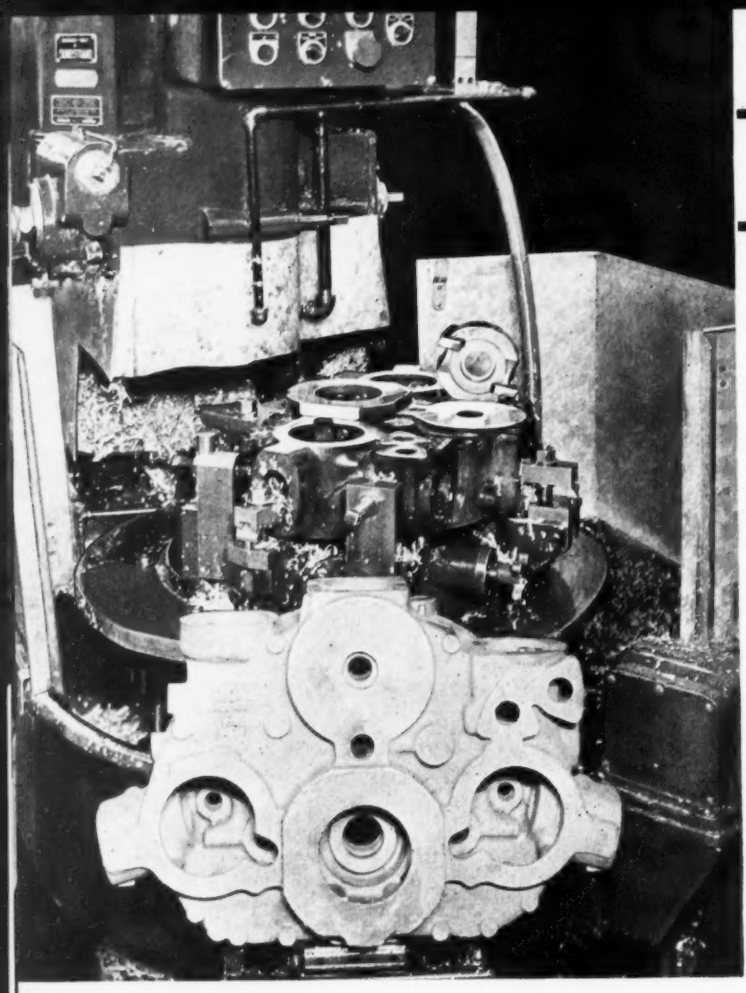


Fig. 2. Machining a Magnesium Blower Section with Fly Cutters Operating at High Speed on a Milling Machine Having a Cam-controlled Cutter-slide



vised a method of setting up which requires only forty-five minutes.

One of the most interesting departments in this plant, from the standpoint of machine tools and tooling, is that devoted to the production of blower sections, which are magnesium castings. All operations on these castings are performed with a coolant, which is contrary to the practice of some plants that machine magnesium dry in order to minimize the fire hazard. This coolant, however, has been specially developed by the General Motors Research Laboratories to provide a satisfactory deterrent to fire.

Fig. 2 shows a Sundstrand vertical-spindle milling machine equipped for the high-speed finishing of a joint face on the intermediate blower section by the use of fly cutters. The cutting edges are 2 1/2 inches from the center of the machine spindle, and the cutter-spindle is run at a speed of 1590 R.P.M., so that a linear speed of approximately 2080 feet per minute is obtained. Stock 1/8 to 3/16 inch deep is removed in one cut by the tungsten-carbide cutter bits. The table runs at 0.5 R.P.M.

Since the flat joint face on this blower section follows an irregular outline, it is necessary to provide the work with both a rotary and an in-and-out motion. The in-and-out movements are obtained through a large cam on the rotary table, which may be clearly seen in the illustration. A roller mounted on the cutter-slide is held against this cam under hydraulic pressure, with the result that the cutter-slide moves back and forth in accordance with the rises and falls of the cam as the table revolves.

The Sundstrand milling machine shown in Fig. 3 is equipped with two cutter-spindles for finishing seven pads on the rear crankcase section to two different heights. Each cutter-head is provided with two tungsten-carbide tool bits,

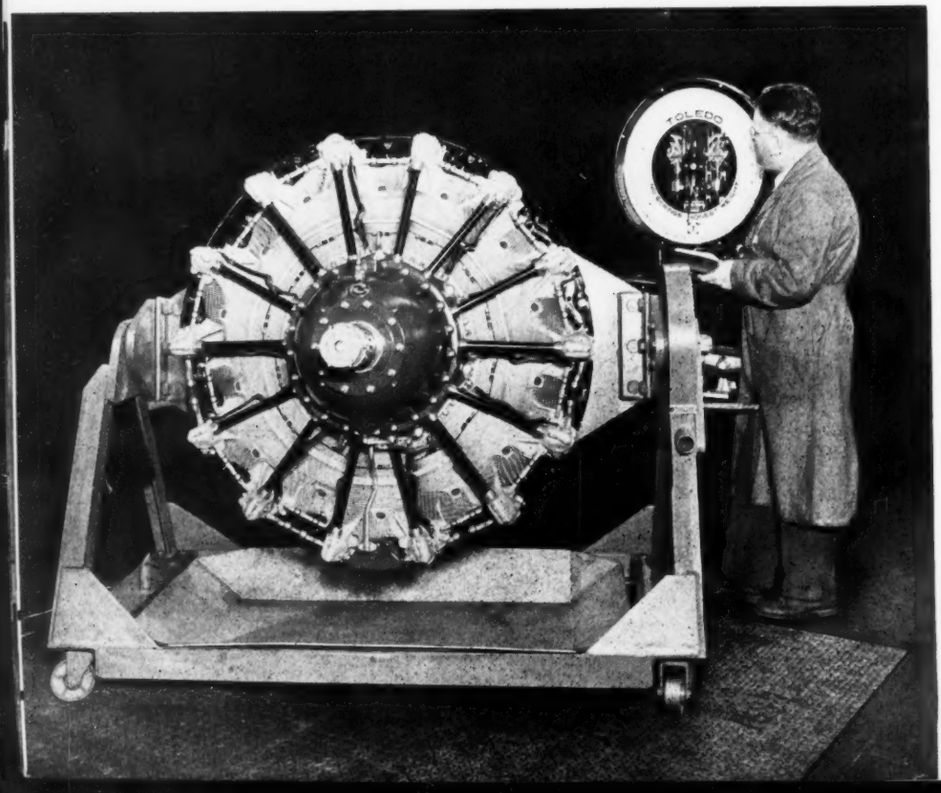


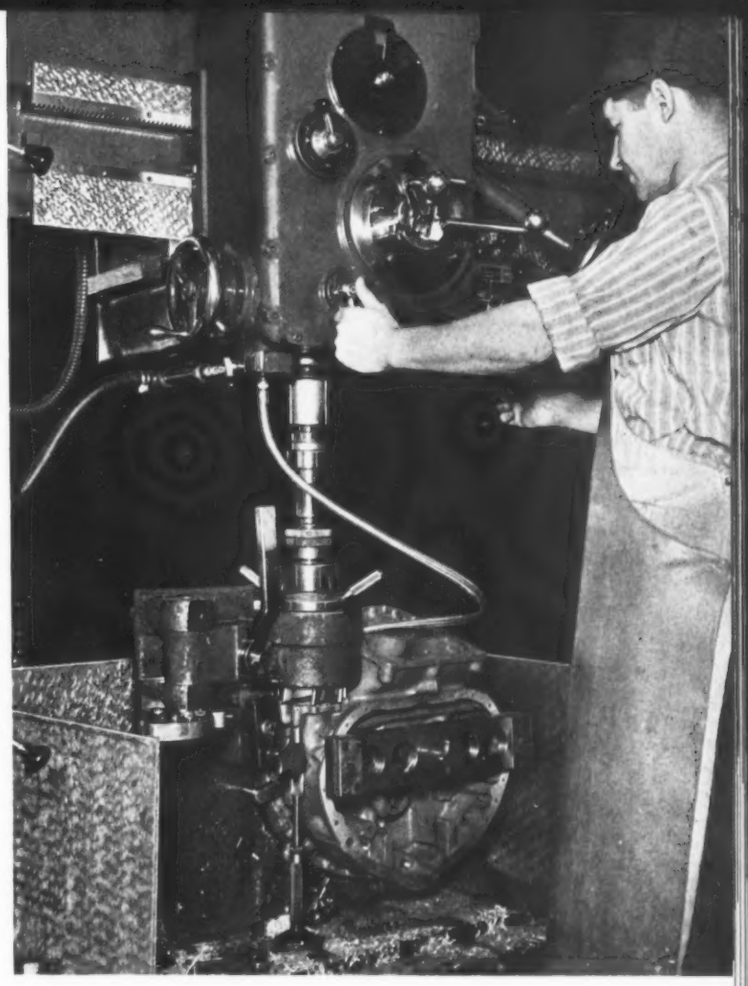
Fig. 3. (Above) Another Milling Machine Equipped with High-speed Fly Cutters for Milling Pads to Two Different Heights on Magnesium Castings

Fig. 4. (Left) Checking the Weight of an Aircraft Engine Immediately after it Leaves the Assembly Line, while it is Still Mounted on the Trunnion Type of Assembly Carriage

disposed as seen on the cutter-head that lies on top of the work-piece on the circular table. The two cutter-spindles are in a straight line from front to back. The cutters on the forward spindle finish the large central pad seen near the bottom of the casting that rests on a tote box at the front of the machine, while the other cutter-head machines all the remaining pads.

As on the machine in Fig. 2, there is a large cam on the rotary table which gives the cutter-slide a backward and forward movement coincidentally with the rotation of the work. In this operation, the pads must be machined to the specified heights from a finished face on the opposite side of the casting, within 0.002 inch. The use of fly cutters as described gives the work an unusually fine finish.

After several more operations, the rear crankcase casting reaches the Heald Bore-Matic illustrated in Fig. 6, which is provided with four spindles having a total of eleven tungsten-carbide cutters for finishing bores in the center of four of the pads that were finished in the operation just described. Each spindle machines two or more diameters. All bores are held within plus or minus 0.0002 inch of the specified center distances, while the diameters must be held to size within plus or minus 0.0005 inch. Later on bronze bushings are assembled in some of the bores and they are also precision bored. This operation is typical of aircraft engine building on a mass production basis.



Radial drilling machines are employed for a wide variety of operations on the rear and intermediate blower sections, because the spindle can be readily positioned at various points on the casting for drilling the oil pressure holes, etc. In Fig. 5 an American radial drilling machine is being employed for rough- and finish-facing, in two steps, the selector valve pad on

Fig. 5. (Above) Employing a Radial Drilling Machine for Rough- and Finish-facing Selector Valve Pads on Blower Castings, as Well as for Drilling and Reaming the Parts

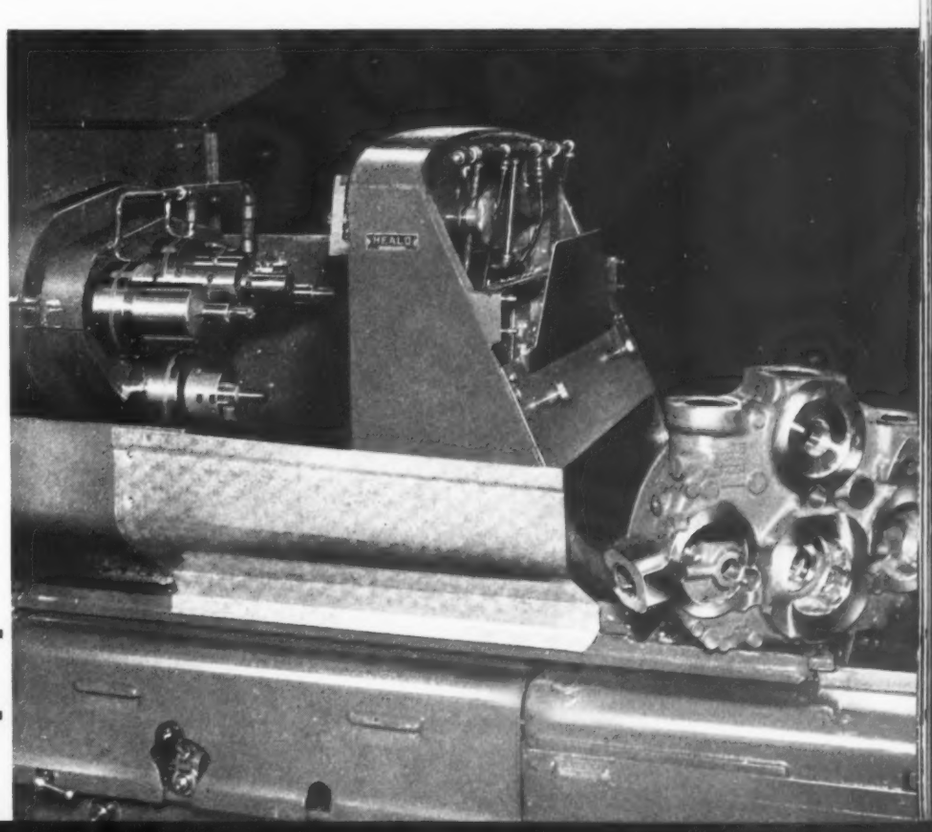


Fig. 6. (Right) Four-spindle Precision Boring Machine Designed for the Simultaneous Finishing of Various Bores in Blower Castings

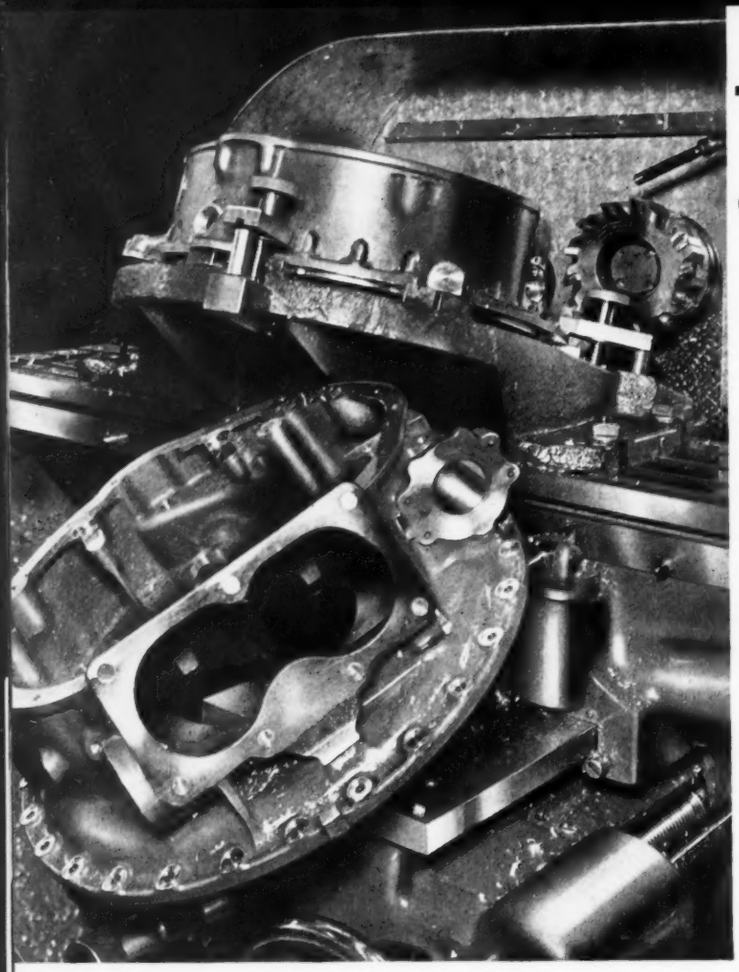


Fig. 7. Milling Machine Set up for Finishing the Carburetor Pad on Magnesium Blower Castings

the intermediate blower section to a diameter of 3 3/4 inches. The casting is accurately mounted on an angle-plate type of jig, which is provided with a swinging arm that carries a large guide bushing for the tool-spindle. Ground piloting surfaces on a sleeve that is mounted above the cutter engage this bushing and insure rotation of the cutter in the required horizontal plane.

The bushing can be changed for guiding drills in cutting two holes in the selector valve pad. In addition, four smaller holes are drilled in the same set-up. Incidentally, after these magnesium castings have been completely machined, they must undergo a water test at a pressure of at least 200 pounds per square inch.

A Van Norman milling machine set up for finishing the carburetor pad on an intermediate blower casting is illustrated in Fig. 7. The nature of this operation will be apparent from the casting that is seen resting on the saddle of the milling machine at the front of the table.

A large number of holes are tapped in the intermediate blower section by the use of Baush tapping machines, a typical operation being illustrated in Fig. 8. Seven holes, 9/16 inch in diameter, with 18 threads per inch, are tapped to a depth of 3/4 inch around the outside carburetor pad, in which operation the casting is held in the position shown. After indexing the fixture, six holes, 5/16 inch in diameter, with 24 threads per inch, are tapped to a depth of 7/16 inch around the inside carburetor pad. Six more holes of the same size are also tapped around a circular boss at right angles to the

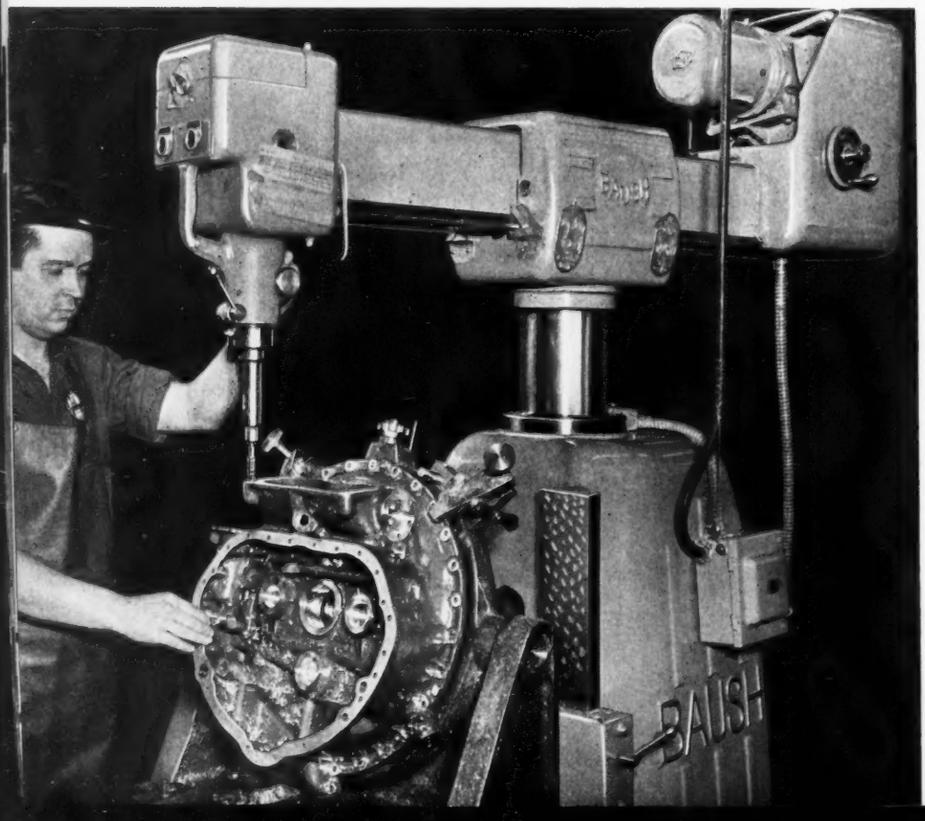


Fig. 8. Radial Arm Type of Tapping Machine Employed for Tapping a Large Number of Holes in Blower Castings

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Fig. 9. Another Type of Tapping Machine Used to Thread Holes in the Crankcase Sections

carburetor pad and four holes 5/16 inch in diameter, 18 threads per inch, are tapped to a depth of 3/4 inch in the selector valve pad. All these holes must be tapped to a Class 3 fit.

Bakewell tapping machines of the construction illustrated in Fig. 9 are used in tapping the hold-down stud holes in the crankcase sections. One hundred twelve holes are tapped in the center section alone, and half that number in both the front and rear crankcase sections. All holes are of 3/8 inch diameter and have 16 threads per inch. These holes, too, must be produced to a Class 3 fit. In Fig. 9 a rear crankcase section is being tapped. It is shown mounted on a fixture that can be indexed into seven positions to locate each cylinder pad accurately in the horizontal plane. The feature of Bakewell tapping machines is that the tap is accurately guided by means of a lead-screw on the tapping spindle.

An Ex-Cell-O precision boring machine of duplex design, equipped with three spindles on each head, is employed to machine the wrist-pin bores in pistons. The piston is placed in the fixture and automatically positioned to first drill, second core-drill, and third bore. The machine is illustrated in Fig. 10. The piston is located first in the rear position, and when the machine is started, two drills 1 1/16 inches in diameter are advanced to drill the wrist-pin holes in line through the solid bosses. The piston is then advanced to the middle position. When the machine is again operated, the piston is core-drilled by two opposing drills, 1 5/16 inches in diameter, which merely increase the size

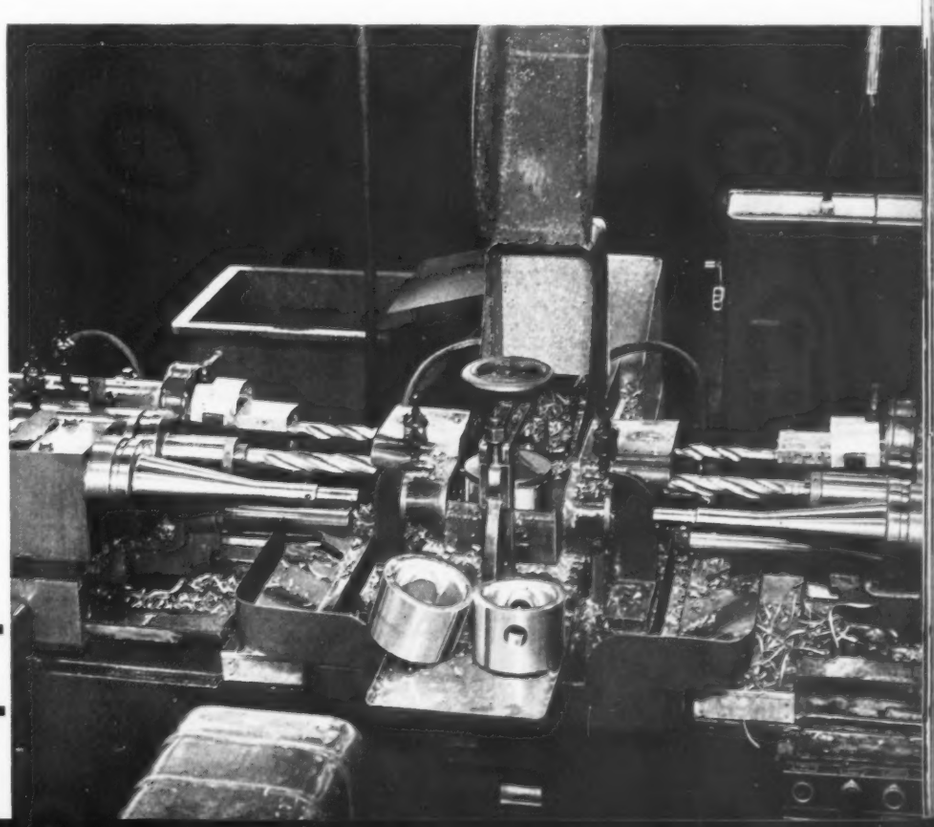

Fig. 10. Machine for Drilling and Boring Wrist-pin Bores of Pistons within Close Alignment and to Accurate Diameter

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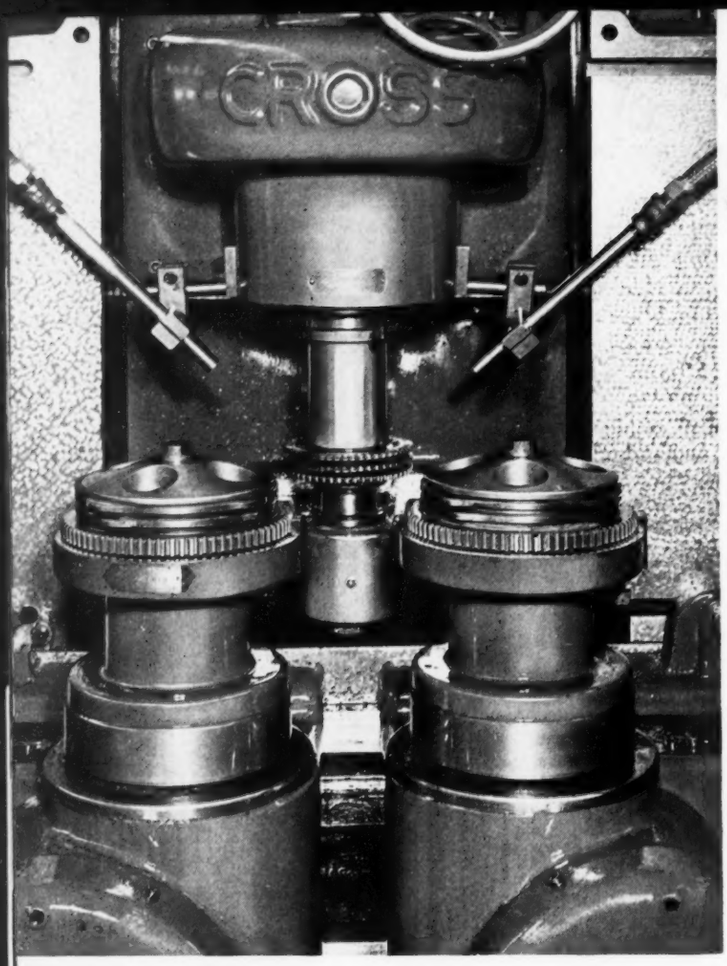

of the wrist-pin holes. Finally, the fixture is advanced to the front position, where the wrist-pin holes are bored and counterbored by tungsten-carbide tool bits mounted on opposite spindles. The bores are finished to specified diameters within plus or minus 0.0005 inch, and they must be in alignment within 0.0005 inch.

A rather unusual tooling set-up was devised for milling timing cams to the required width. The operation is performed on Cross "Mil Lathes," set up as shown in Fig. 11, two timing gears being handled at one time. The cams are revolved on two small circular tables at the front of the machine, and at the same time, three narrow cutters on a slide at the rear are advanced to the milling position. At the end of the operation, the cutter-slide recedes to facilitate reloading. Four surfaces are milled by the three cutters.

Fig. 12 shows a duplex Cimatool machine designed for simultaneously rounding the teeth on intermediate blower gears, as seen at the left, and on magneto drive gears, as illustrated at the right. The cutter-spindles are equipped with circular cutters that resemble hollow mills having three cutting lips. Each time that a cutter is advanced into contact with a gear, it mills the far sides of two adjacent teeth and also the bottom between the two teeth. The cutter-spindles advance to the gears and recede automatically, and between reciprocations, the gears are indexed through a distance of one tooth space. In this way, each tooth is chamfered around its complete profile by the time that a gear has been indexed one revolution. When one side of a gear has been chamfered, it is reversed on the fixture for rounding the opposite sides of the teeth.

A second installment of this article will be published in a coming number of MACHINERY.

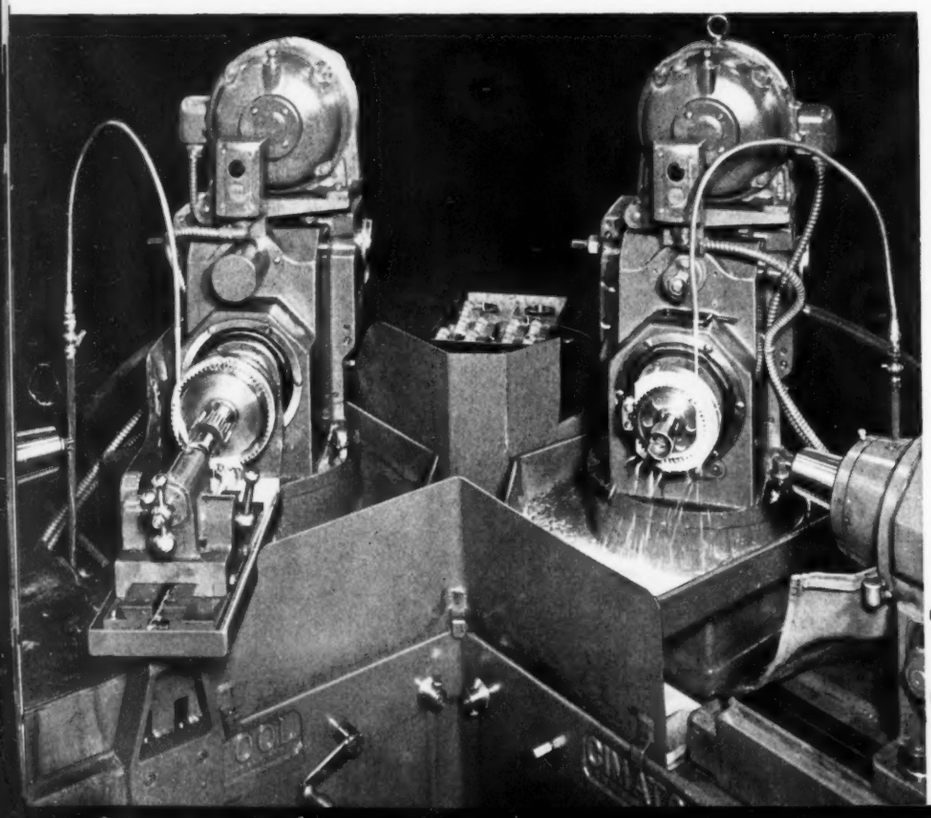

Fig. 11. (Above) Milling Timing Cams to the Required Width, Two at a Time, with Three Milling Cutters of Narrow Width

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Fig. 12. (Left) Duplex Type of Machine Designed for Automatically Chamfering the Teeth on Blower Gears and Magneto Drive Gears

The Douglas Blackout Plant Builds for Victory

By RAY A. STEINBAUER

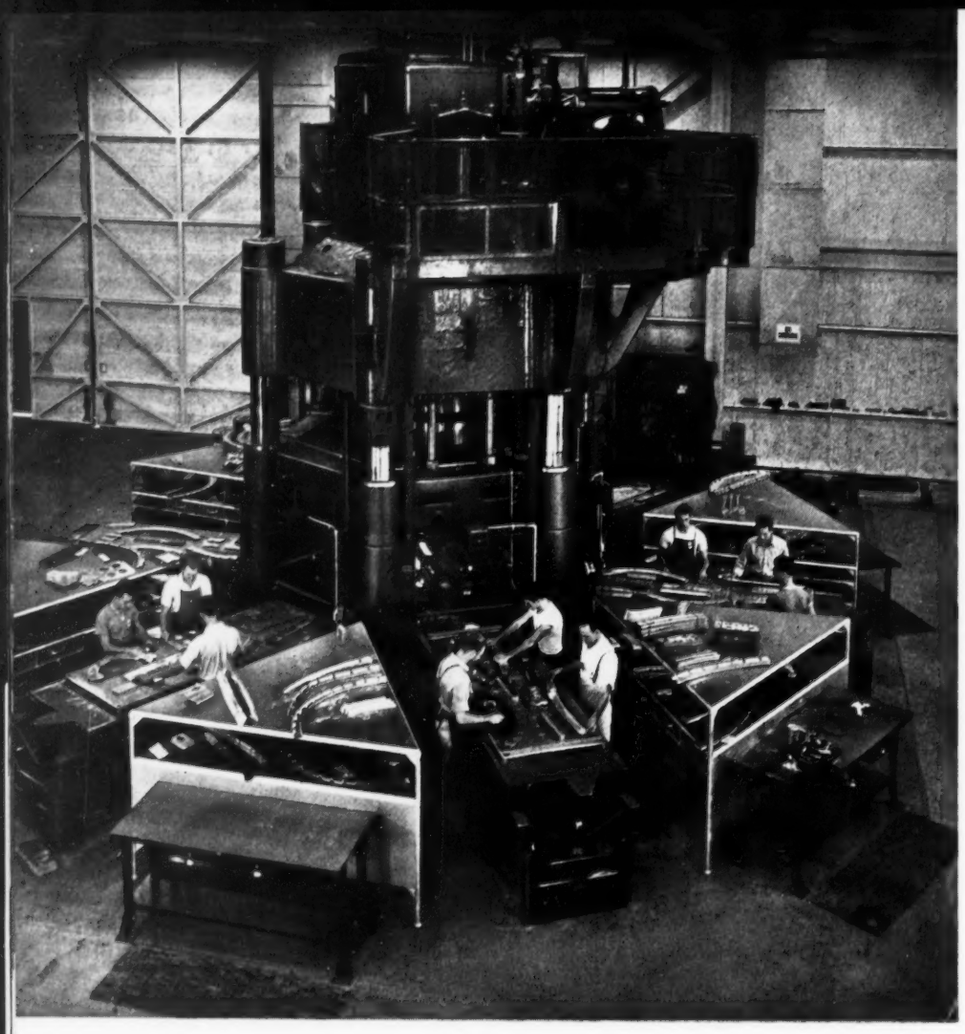

Fig. 1. (Left) Hydraulic Press of Six-sided Construction, Provided on All Sides with Electrically Operated Tables that Permit Constant Operation

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Fig. 2. (Below) Looking down an Aisle in the Machine Shop of One of the Great New Factories of the Aircraft Industry—the Douglas Aircraft Co.'s Windowless, Artificially Lighted, and Air-conditioned Plant

Douglas Blackout Plant Builds for Victory

Manufacturing Operations in One of the First of the Great New Plants Completed by the Airplane Building Industry

By RAY A. STEINBAUER
Superintendent of Machinery and Parts Production
at One of the Plants of Douglas Aircraft Co., Inc.

INTENSE interest in the new California blackout plant of the Douglas Aircraft Co. was exhibited by the airplane manufacturing industry during the time that this plant was under construction, and even after some months of operation, the interest in its manufacturing methods has scarcely abated. This is not remarkable, in view of the fact that this huge plant was planned from the "ground up," so that engineers had the opportunity of adopting the most efficient production methods evolved through years of experience in airplane manufacture, of providing the best possible working conditions for the employes, and of so constructing the buildings as to make them as little susceptible as possible to damage from enemy bombers.

The plant comprises a number of buildings constructed of concrete and steel which have no windows whatsoever, so that they are always blacked out at night. All doors are provided with light traps, so that no illumination shines through them when they are opened. Artificial lighting is provided throughout the plant day and night by thousands of glareless fluorescent and mercury vapor lights. Ordinarily, the lights are not turned off week upon week. The entire plant is air-conditioned by the largest air-conditioning system on the Pacific Coast. On warm days, the air within all the buildings is maintained at from 10 to 15 degrees cooler than on the outside. Air-conditioning has been of material benefit in attaining maximum production, through reduced fatigue of the workers.

The machine shop is believed to be one of the finest in the world, from the standpoint both of the modern machines and their tooling, and the lay-out of production lines. From the general view of the machine shop shown in Fig. 2, it will be seen that electrical conduits and lines of compressed air extend horizontally above the rows of machines within convenient reach of machine operators and maintenance men. Junction boxes and switches for the various machines can be readily located at desired points along these lines. Alternating current of 110 volts is available for electric lights and of 440 volts for driving the machine motors. The horizontal conduits and pipe lines are supported from above by connecting conduits and pipes.

This article will deal principally with operations in the machine shop, but will also describe some of the outstanding methods employed in the fabricating departments. As it is not possible to mention exactly what types of planes are built in this particular plant, for military reasons, it must be sufficient to state that Douglas plants are turning out bombers, attack ships, night fighting planes, transports, and troop carriers in numbers that will bring consternation to our enemies.

Probably the most spectacular metal-working machines in the plant are two huge Bliss hydraulic presses, of 2500 tons capacity each. From Fig. 1 it will be seen that these presses are of six-sided construction. Electrically operated tables are provided on the six shades, which are automatically moved into position in sequence under the press ram for forming and stamping sheet-metal parts over forms of rolled Kirksite. At the end of the operation, each table is automatically returned to its loading position.

On each side of the press there is a vertically sliding window, which is automatically raised to permit the corresponding table to be pushed beneath the press ram, and then immediately lowered to prevent any operator from extending an arm under the descending ram. The tables can be made to operate in any desired sequence, and when less than six tables meet production requirements, the electrical drive to some of them can be turned off.

Fig. 3. Stretching a Duralumin Sheet, Both Lengthwise and Crosswise, to the Shape of a Zinc Pattern, for Use as Cowling on an Airplane

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When any table is under the press ram, the loaders of the next table to go under the ram are notified by the turning on of a light in a box in front of the corresponding window, which illuminates the word "Next" in red. In this manner, the men who load the tables are warned of the limited time in which they must complete their work. When the time comes for the table to be pushed on the press bolster, the word "In" is illuminated instead of "Next." The operators in any of the six stations can adjust the applied pressure to suit the work on their table, and the machine can be stopped from twelve locations, although it can be started from only one position.

The production of these two hydraulic presses is so high that they keep the entire plant supplied with the required shallow formed and blanked parts. The Guerin process of forming is employed, rubber pads 9 inches thick being provided on the press rams. This process was developed by the Douglas Company, and is used under license throughout the aircraft industry.

Deep-drawn duralumin parts are produced either on Cecostamp pneumatic hammers or on double-action hydraulic presses. Erco stretching machines, of the type shown in Fig. 3, are employed to shape a variety of parts, such as cowling pieces, from strips of material that may vary considerably in width.

The advantage of these machines is that, while the metal stock is securely clamped at both ends, a central table can be raised by hydraulic

Fig. 4. Sheet-metal Pieces of Comparatively Narrow Width are Bent and Formed to Required Shapes on Bulldozers

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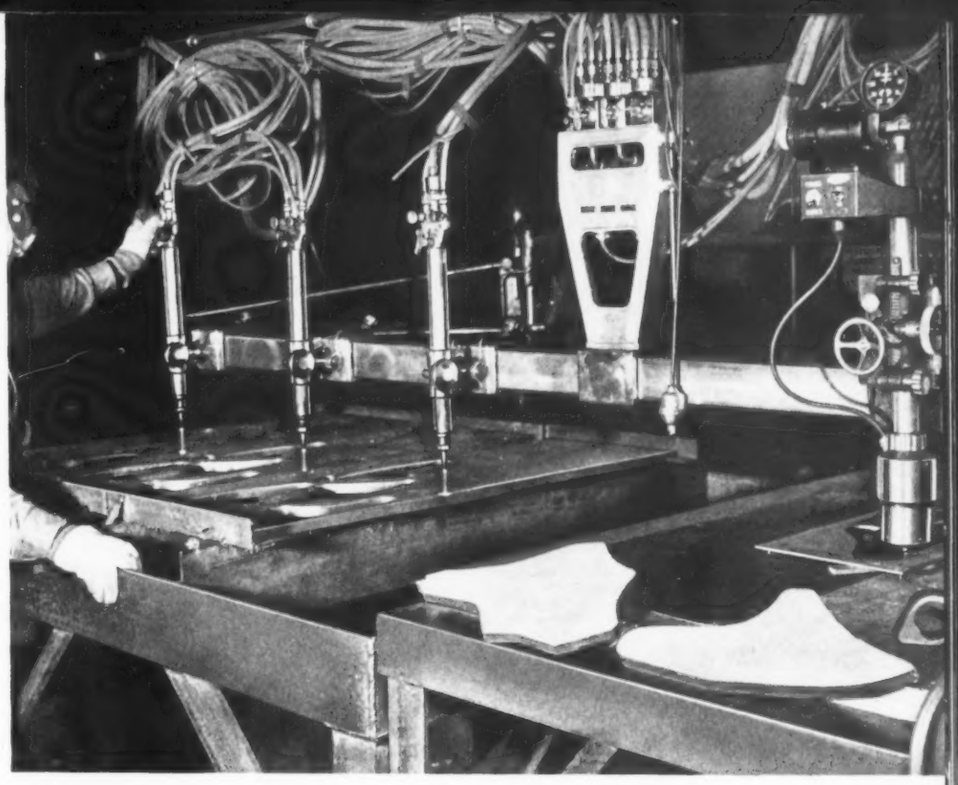

Fig. 5. Cutting out Three Wing-attaching Terminal Plates at a Time on an Oxy-acetylene Machine Equipped with Three Torches

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power, which causes the metal to permanently assume the shape of a Kirksite or wooden form mounted on top of the table. As the table is raised through the action of pistons in two hydraulic cylinders, it is possible to incline it at the required angles by the manipulation of the handle controls seen at the right-hand end of the machine. Sheet metal can be stretched both lengthwise and crosswise to obtain practically any desired shape. The machine shown has a capacity of 300 tons.

Some sheet-metal pieces of comparatively narrow width are bent and formed to the required shapes by the use of Steelweld bulldozers, as shown in Fig. 4. A Kirksite die is mounted on the stationary anvil of this machine, and a punch of similar material is held on the ram. In an operation, a blank of sheet duralumin placed in the die is bent to a U shape when the punch moves horizontally into the die, and at the same time, a square bead about 1 inch wide and 1 inch deep is formed the full length of the part, except for the two ends. This machine has a capacity of 40 tons.

Oxy-acetylene cutting machines are being used in a novel manner for producing parts quickly to irregular outlines. These machines make such smooth cuts that no finishing operations are required on the flame-cut surfaces. Fig. 5 shows an Airco Oxygraph machine being used for cutting out wing-attaching terminal plates from S A E 4340 chromium-molybdenum steel

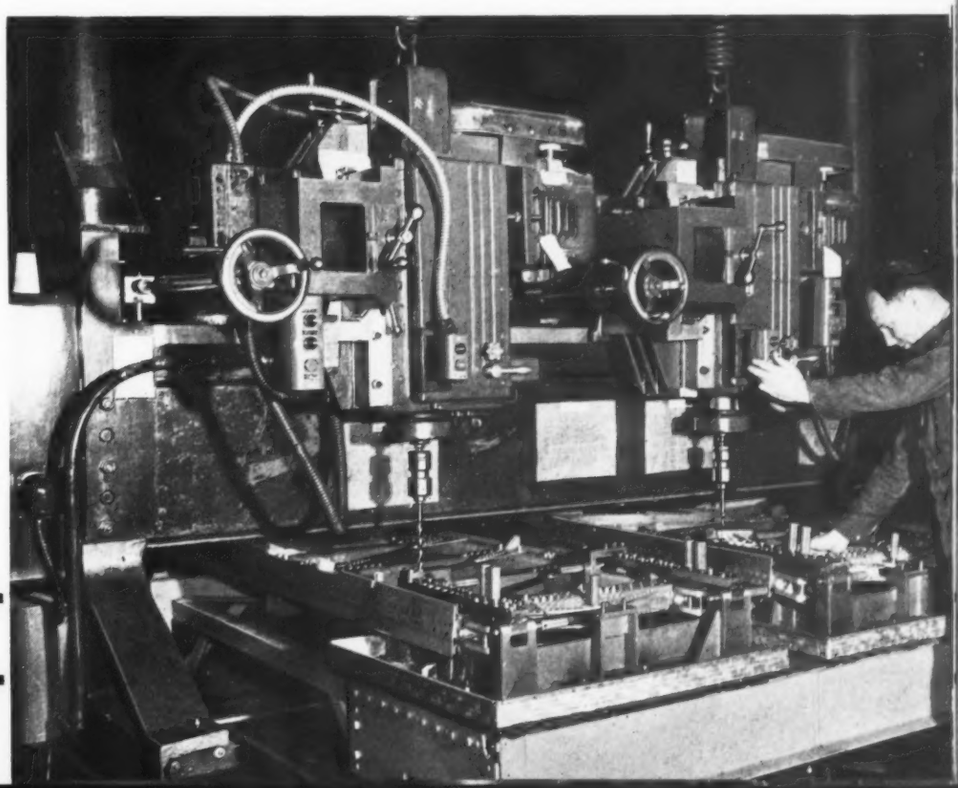

Fig. 6. Special Equipment Designed for Drilling Holes in Spars to Match the Holes in the Wing Terminals

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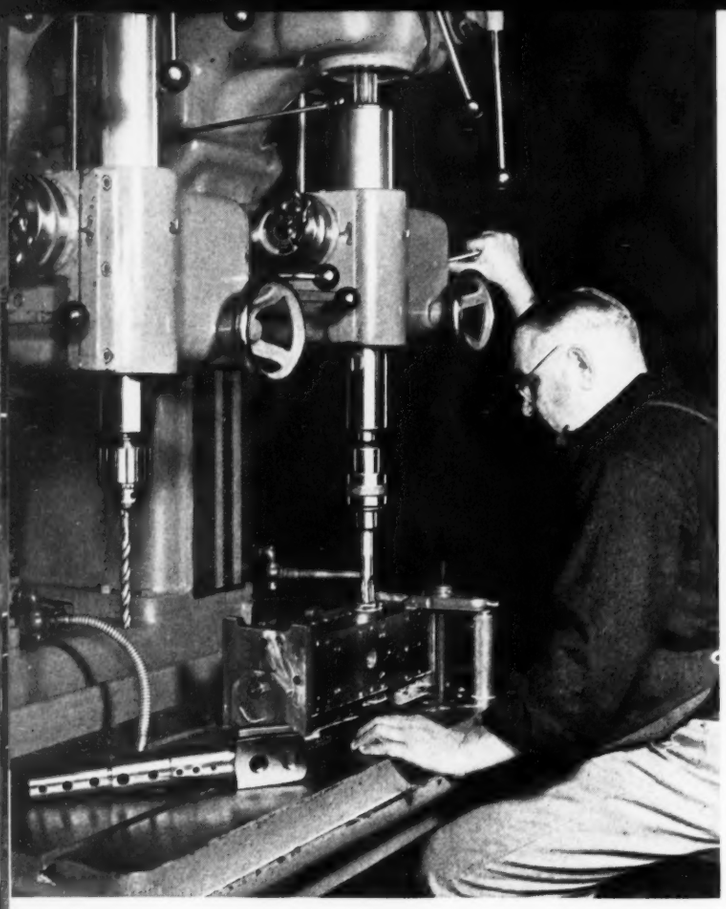

Fig. 7. Two-spindle Machine Employed for Drilling the Holes in the Shank and Jaws of Wing-spar Terminals

3/4 inch thick. Through the provision of three torches, a like number of parts are simultaneously produced as the magnetic tracer automatically follows a templet on the table at the right. Two typical terminal plates are seen at the front of this table. The stock is preheated to 600 degrees F., so as to avoid the development of thermal cracks. After being cut out, the terminal plates are normalized, and then sent to the machine shop for grinding the sides and drilling the necessary holes.

On the templet table may also be seen a hanger which is cut by the oxy-acetylene method from chromium-molybdenum steel 1 1/4 inches thick. Both the outside contour and the hole are produced by the oxy-acetylene torches within fairly close tolerances. A small hole is drilled through the part prior to the operation to facilitate the start of the oxy-acetylene cut, and the slight unevenness left at this point must later be ground away. Otherwise, there is no machining performed on either the internal or external surfaces. The use of oxy-acetylene cutting machines for operations of this kind has effected large savings in time.

A special machine built in the Douglas toolroom for drilling spars to match holes in the wing terminals that are attached to the spars is shown in Fig. 6. Eight holes ranging from 9/32 to about 5/8 inch in diameter must be drilled for each terminal. The spars are placed on a long structural-steel table for this operation. The end of the table that is beneath the drilling machine is provided with jigs in which the wing terminals are set up before the spars are loaded on the table. Each terminal is accurately located in the jig by plugs that pass through bushings in the jig plates and into reamed holes in the terminal jaws. The holes in

Fig. 8. Milling Machine Set-up Employed for Finishing Both Sides of Pads at Various Points around Forged Engine-mount Rings

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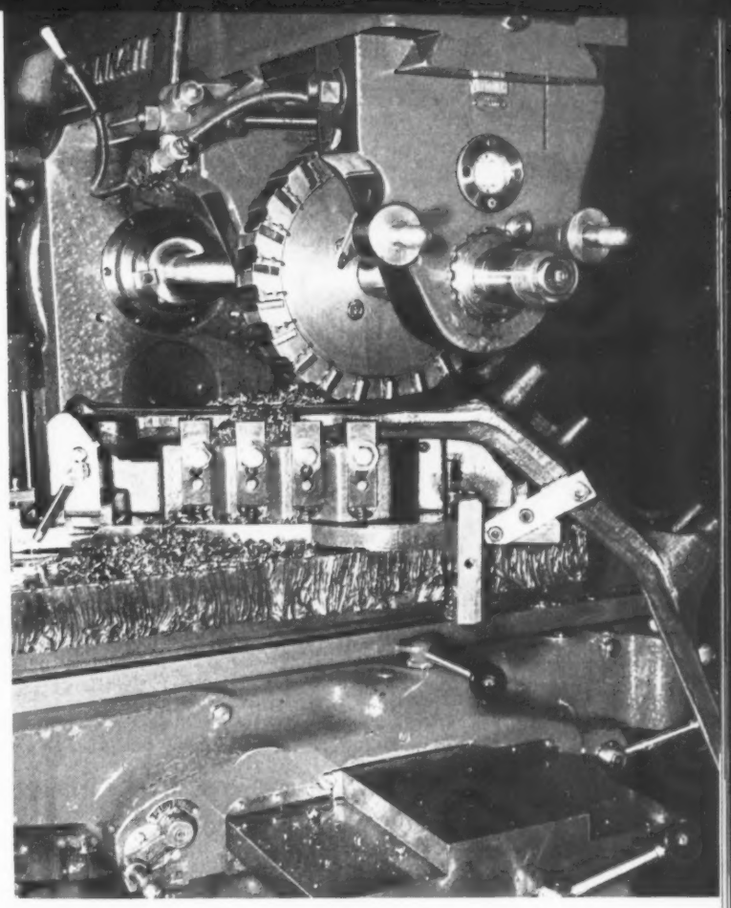

Fig. 9. Milling Machine Set up for Removing Stock from the Arms of K-type Landing-gear Trusses

the spars are drilled through the actual terminal shanks and through both sides of the spars. Correct location of the holes is insured by the jig bushing plates.

Drilling is performed by means of two Ex-Cell-O heads which are mounted on comparatively short arms that extend at right angles to the cross-rail of the machine and are adjustable sidewise on the cross-rail. This construction permits complete sidewise adjustment and a limited front and back movement of the drill heads. However, the entire machine frame is movable lengthwise to enable the drills to be placed in any required position above the spars.

The holes in the wing-spar terminals are drilled on Cleereman two-spindle drilling machines provided with suitable jigs, as illustrated in Fig. 7. Drills for the 1 1/64-inch holes produced in the jaws of the terminals are used on the right-hand head, and this head is also employed for reaming the jaw holes. The holes in the shank are produced by using drills of various sizes in the spindle of the left-hand head, and are drilled through both walls of the hollow shank. These terminals are S A E 4135 chromium-molybdenum steel forgings.

Practically all the machine tools in this plant are of standard design, fitted with jigs, fixtures, and tools to meet specific needs. In Fig. 8 is shown a Van Norman milling machine equipped for finishing eight pads around engine-mount rings. These rings are in two pieces. Both sides of the pads are milled in two settings to a width of 1.688 inches within plus 0.005 inch, minus nothing. Simple clamps are provided for securely gripping the ring on top adjacent to each pad, and there are additional clamps that support the ring members where the two halves come together. The fixture is indexed by hand

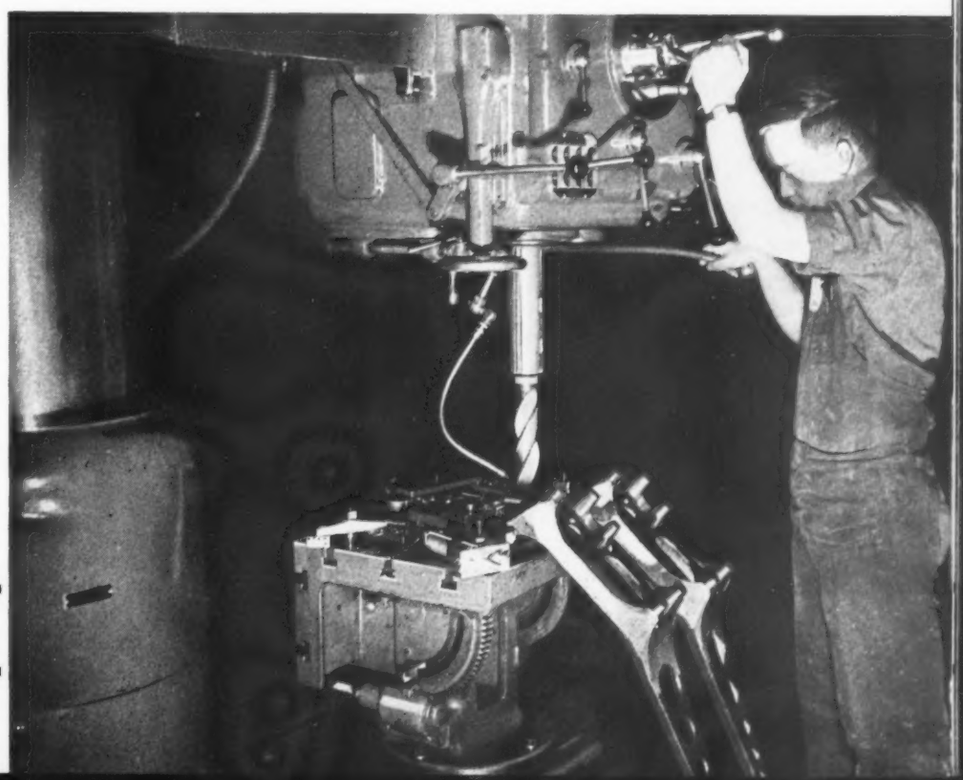

Fig. 10. Lightening Holes being Drilled in the K-type Landing-gear Trusses on a Radial Drilling Machine Using Drills and Fly Cutters

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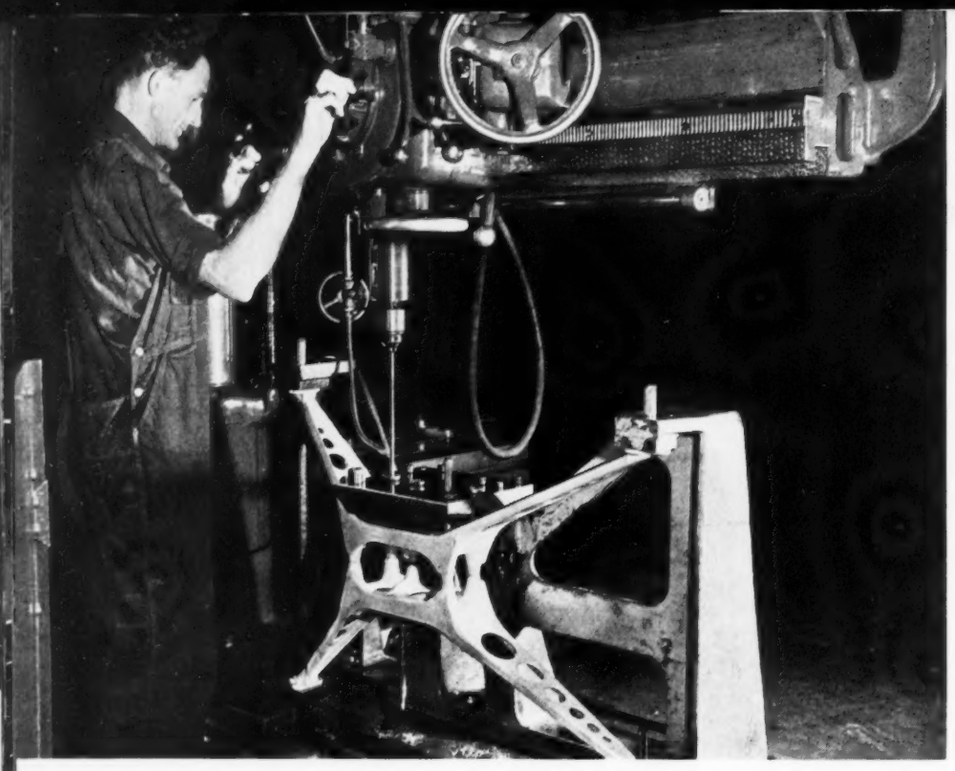

Fig. 11. Line-reaming the Connecting Holes of Two K-type Landing-gear Trusses, which are Then Kept together to be Assembled as a Pair on an Airplane

to bring the various pads successively into the cutting position. It is locked in place during a cut by a locating pin which engages dowel-holes in the circular edge of the fixture.

In Fig. 9 a Cincinnati milling machine is seen equipped for milling the arms of K-type landing-gear trusses. The design of the forging is such that when one arm is being milled the other arm must hang down over the front of the table and clear the knee. To allow for this, the fixture is mounted in an angular position on a base of Kirksite, the latter being, in turn, fastened to the table of the milling machine.

The operation consists of thinning down the arms, it being impossible to forge them as thin as desired, due to the awkward shape of the forgings. Cuts of 5/16 inch average depth are taken by the 12-inch diameter inserted-blade cutter on these S A E 4135 forgings.

Lightening holes are subsequently drilled in these truss arms on American radial drilling machines equipped with a conventional tilting table and simple fixture, as shown in Fig. 10. The lightening holes range in diameter from 3/4 inch to 3 3/8 inches, holes up to 2 1/8 inches diameter being drilled, and the larger holes being produced with fly cutters of the type seen lying at the front corner of the table.

As these landing-gear trusses are used in pairs on airplanes, the five holes required to bolt them together are line-reamed after drilling, with both trusses located accurately in respect

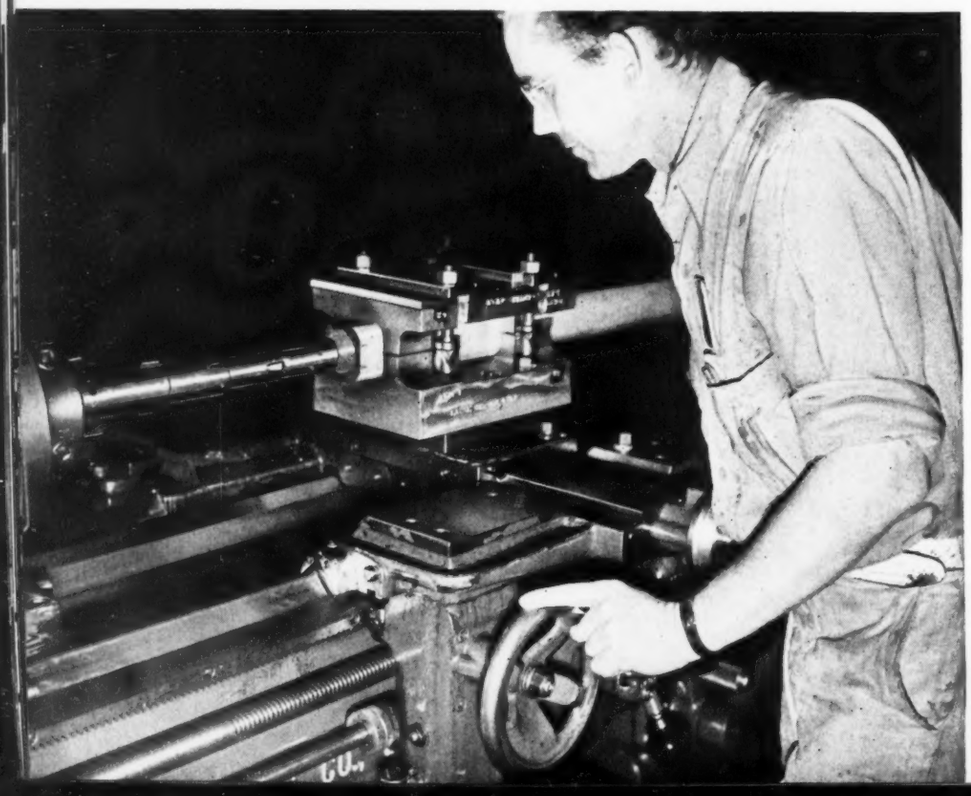

Fig. 12. Boring the End of Spar Caps to Four Different Diameters on an Engine Lathe, the End of the Caps being Faced at the Same Time

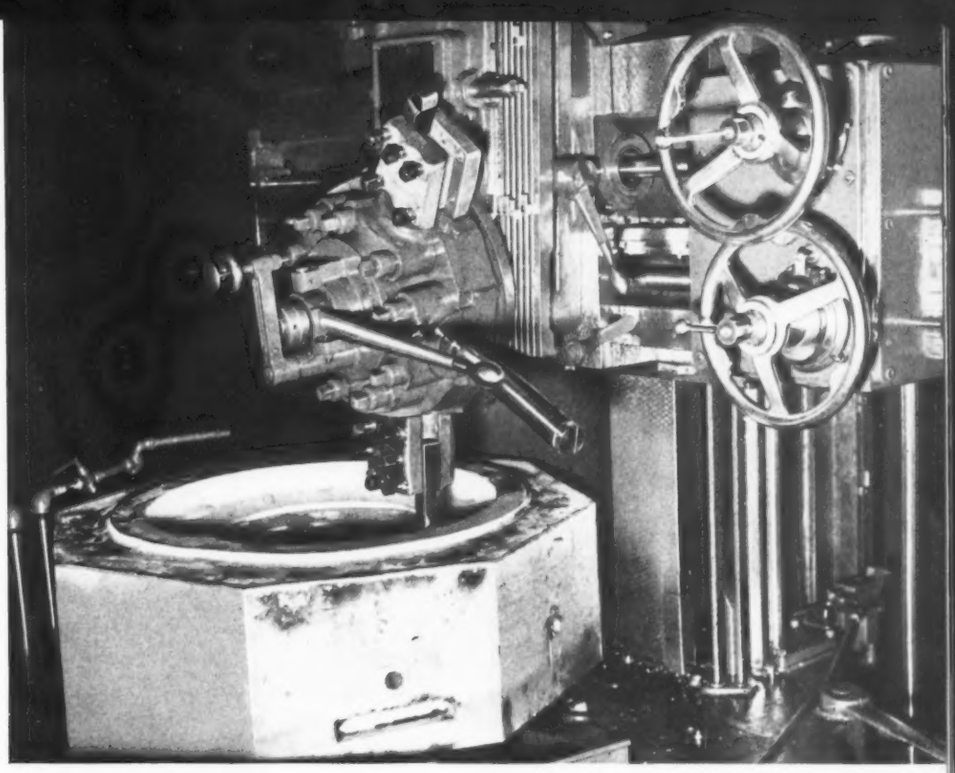

Fig. 13. Employing a Vertical Turret Lathe for Machining a Zinc Die which is Considerably Larger in Size than the Diameter of the Machine Table

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to each other. Fig. 11 shows the line-reaming operation being performed on a Cincinnati Bickford radial drilling machine. The two trusses are located in the jig by plugs inserted through reamed holes in the truss legs. In addition, another hardened and ground plug is inserted through one of the bushings in the jig plate and into one pair of the drilled holes in the trusses which are to be reamed in this operation. As soon as a pair of holes has been reamed, the latter plug is transferred to those holes. Upon the completion of the line-reaming operation, wire is wrapped around the two trusses to make certain that the two members that have been reamed at the same time will be assembled together on a plane.

Spar caps on one type of plane built in this plant consist of duralumin tubes, 26 feet in length, which are of square cross-section both on the inside and outside. One end of these spar caps must be bored to four different diameters to receive wing terminals somewhat similar to the type drilled in the operation shown in Fig. 7. The boring operation is performed on the Axelson engine lathe illustrated in Fig. 12, which is supplied with a special fixture on the carriage in place of the compound rest. The front end of the spar cap is securely gripped in this fixture, square with the headstock spindle.

Mounted in the lathe chuck is a four-step boring-bar provided with cutters that cut on both sides of the bar in machining to the four

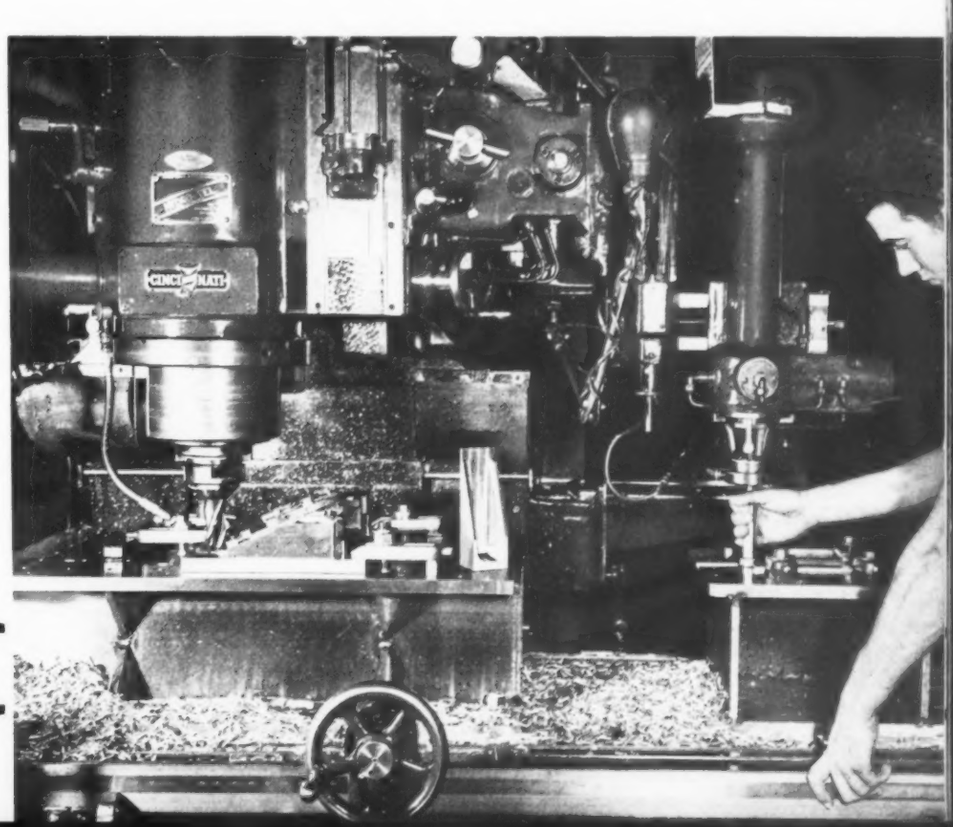

Fig. 14. Milling Duralumin Hangers to Irregular Shape in a Set-up that is Typical of Many Employed on Hydro-tel Milling Machines

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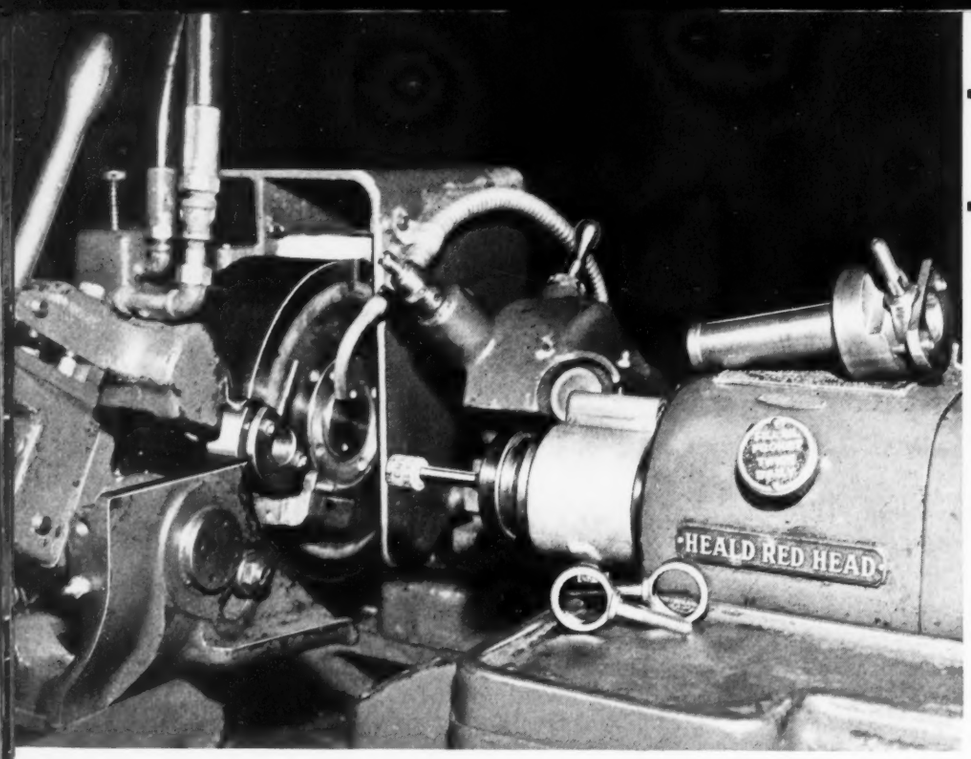


Fig. 15. The Internal Centerless Grinding Process is Employed in Finishing the Holes in Aileron Hinge-eyes by the Use of a Special Work-holding Adapter

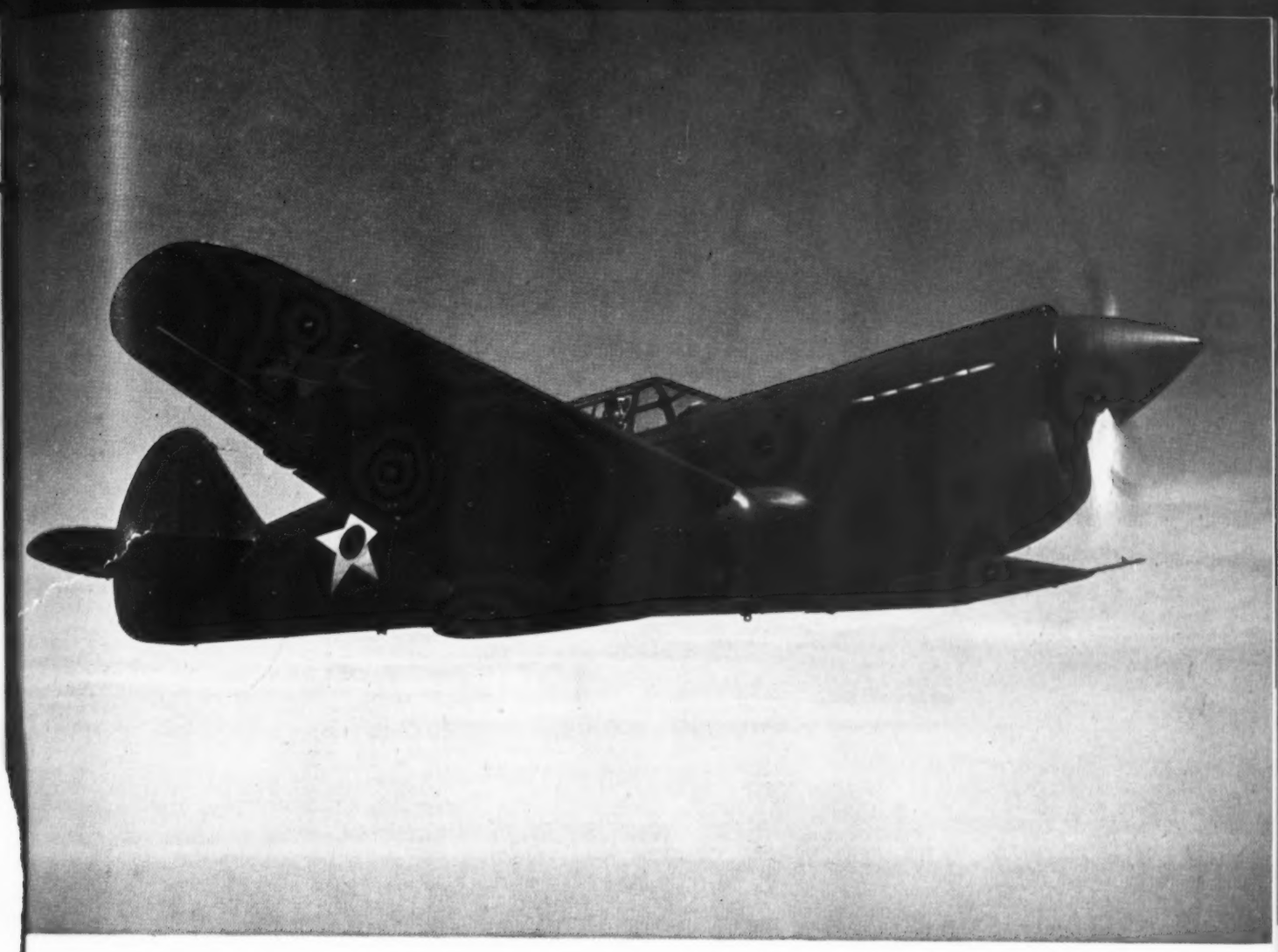
required diameters. There is also a fifth tool for facing the end of the spar cap. All the bored diameters are held to size within plus 0.002 inch, minus nothing, in spite of the fact that the boring-bar is approximately 18 inches long.

Landing-gear parts and similar pieces are normally bored on the Bullard Cut Master vertical turret lathe shown in Fig. 13. However, at the time that the photograph was taken, this machine was engaged in boring, turning, and facing a large zinc die that measured 43 inches across, although the nominal swing of the table is only 30 inches. The die weighed approximately 4000 pounds.

A Cincinnati Hydro-tel milling machine set up for automatically finish-milling hangers to the required irregular shape is shown in Fig. 14. These parts are roughed out from duralumin ST forgings on standard vertical-spindle milling machines, and come to the Hydro-tel milling machine for finishing accurately to the required dimensions. Owing to the shape of the part, the width of the cut increases considerably as the tool is fed into the work, and likewise decreases as it is fed out. For this reason, the operator controls the speed of the cut by retarding or releasing the magnetic tracer as it moves around the templet mounted near the right-hand end of the table. A conventional type end-mill, 1 1/2 inches in diameter, takes the cut. This machine is also used for a variety of other parts of irregular shape.

Holes in aileron hinge-eyes are finished to a tolerance of 0.001 inch by the Heald internal centerless grinding machine shown in Fig. 15. The hinge-eye is mounted on an adapter such as seen lying on top of the grinding head which has a shank that is inserted between the driving rolls of the machine. In this way, the adapter is revolved and the work with it. It is impossible to place the hinge-eye itself between the driving rolls because of its threaded shank. The construction of the adapter is such that the shank on the hinge-eye revolves in front of the driving rolls. The adapter shank has a shoulder at one end which contacts with the left-hand end of the driving rolls and thus prevents the adapter from moving forward during the grinding operation. About 0.007 inch of stock on a side is removed from the hinge-eye hole.

Additional interesting operations performed in this plant will be described in a second installment of this article, to be published in a coming number of MACHINERY.



CURTISS KITTYHAWK P-40D PURSUIT

How Curtiss-Wright Produces Famous Fighting Planes

By P. N. JANSEN, Director of Manufacturing
Airplane Division, Curtiss-Wright Corporation

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Fig. 1. Primary Wing Assembly Lines, in which the Wings are Progressively Built up from the Nose, or Leading Edge

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Fig. 2. Final Assembly Lines of the Curtiss Warhawks, Huge Cargo Transports being Seen in the Left Background

Curtiss-Wright Produces Famous Fighting Planes

Some of the Production Methods Employed in Turning Out the Noted Pursuit Planes of the P-40 Series Popularly Known as Tomahawks, Kittyhawks and Warhawks

By P. N. JANSEN, Director of Manufacturing
Airplane Division, Curtiss-Wright Corporation

THE manufacture of military airplanes has been an important business of the Curtiss-Wright Corporation ever since the days of the first World War. Constant application of engineering ability to the development and production of this type of aircraft during peacetime placed the concern in the enviable position of being able to supply our Allies with large numbers of planes soon after the outbreak of the present war in Europe. It was the first airplane building company in the Western Hemisphere to have its pursuit ships formed into squadrons for the battles over Europe. Today Curtiss-Wright pursuit ships are in action on every battle front in the world.

This article will deal with manufacturing operations in one of the plants of the Airplane Division of the Curtiss-Wright Corporation in which are produced pursuit planes designated as P-40's for the U. S. Air Forces. These fighting ships have developed from the first P-40 through the Tomahawks, Kittyhawks and Warhawks, in which have been incorporated many changes, resulting in higher speed, higher ceiling, higher firing power, and more maneuverability. These planes are being built in numbers undreamed of several years ago, as is indicated in Fig. 2, which shows a portion of the final assembly lines.

From these final assembly lines, operated twenty-four hours a day and seven days a week, have come planes that have chalked up decisive victories in every war-torn sector of the world. The Tomahawks proved themselves in Burma, where the Flying Tigers, the American volunteer group, protected the Burma Road against overwhelming odds. These same airplanes in the hands of Australian pilots gained the respect of Nazi and Italian fliers over the Lybian Desert.

In the same Curtiss plant are produced large transport planes for rapidly carrying troops, and even anti-tank guns or jeep cars, to strategic areas. This plant is one of the newest in the airplane industry, and it assembles and delivers the products of two plants, one of which supplies many sub-assemblies and parts. Within seven months after ground had been broken for the erection of this plant, it had been fully equipped and airplanes were being turned out.

The P-40 pursuit ship is a direct development from the P-36 which, in 1938, was conceded to be one of the finest pursuit planes in the world. Rapid development by Curtiss resulting in aerodynamic refinement, greater firing power, and higher speed, combined with actual combat experience in the present world conflict, made the P-36 an obsolete airplane within eighteen months from the time it was brought out. It is, therefore, of considerable interest to review the tremendous differences in performance between a plane that had attained nation-wide fame only four years ago and its present successors. The P-36 pursuit plane carried the standard armament for all contemporary planes of the same classification, that is, one 0.50-caliber machine gun and one 0.30-caliber machine gun.

The striking power of the Curtiss Warhawk, details of which are restricted by the War Department, has been increased many times until it has become known as one of the hardest hitting fighter planes in service today. Despite the considerable increase in weight made necessary by heavier armament, the maximum speed also has been increased. These deadlier Warhawks are rated by American Air Forces as high-altitude "pursuits" in the 400-mile an hour class.

Wartime production schedules for these Kittyhawks and Warhawks have enabled manufacturing methods to be adopted that insure strict interchangeability of all parts. This makes it possible to send replacement parts of any cat-

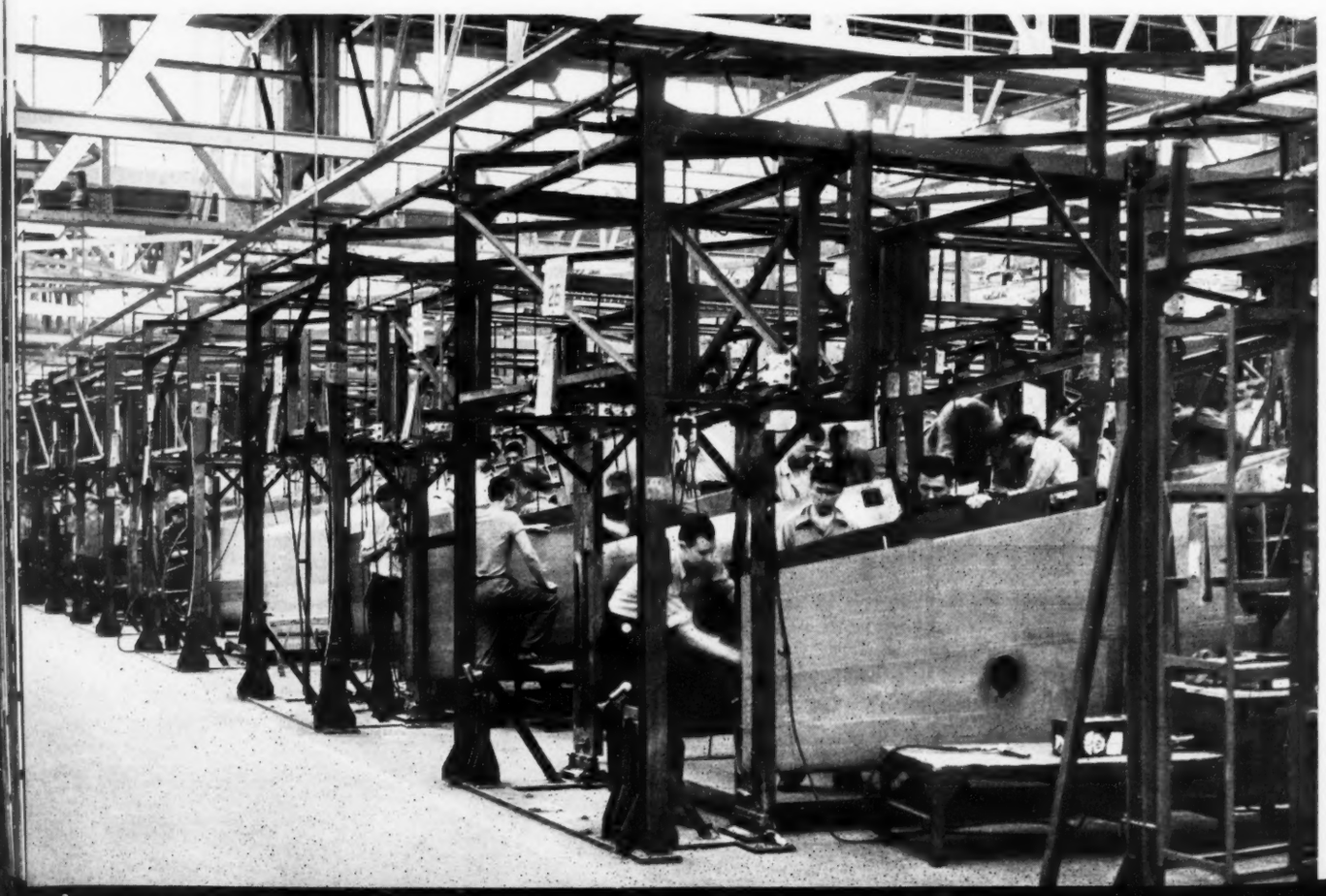
egory to all fighting fronts with the knowledge that the parts can be assembled to damaged planes without difficulty. Jigs and tools of improved design are used for the fabrication of fuselages, wings, tail sections, and so on. Some of these jigs, as in the case of the wing jigs, are constructed on rollers, which permits them to be moved simultaneously to various stations along the assembly lines, so that the airplane parts being assembled can be worked upon by different groups of men assigned to individual detail operations, instead of being completely assembled in one location by one group of men, as was the practice formerly.

Preliminary assembly operations on wings are seen in Fig. 1. After the leading edge, or nose, has been formed on a Farnham rolling machine to the desired curvature, it is sent to the assembly line shown in the illustration. Here longitudinal spars and vertical bulkheads are riveted in place. At certain time intervals, the wings are moved from one station to the next for riveting successive sub-assemblies in place. When the wings have traveled the entire length of this primary assembly line, they are transferred to fixtures such as seen in Fig. 3, where the alignment of the wings is checked. Additional webs and bulkheads are riveted to the wings while they are in these fixtures, as well as large skin segments, so as to complete the full chord.

Left and right wing sections are seen in Fig. 4 in the next assembly line. At the right are sections in a horizontal position ready to have the edge of the longest chord trimmed, so that an even contact will be obtained when the left- and right-hand panels are joined. At the left are seen wing panels with hydraulic-line landing lights and wiring installed. When the wings reach the end of this assembly line, they are routed to the paint department for camouflaging.

Stabilizers are also built up from a leading edge, or nose section, by using webs, bulkheads, and stringers, all of which are riveted to Alclad stressed skin. As in the case of the wing panels, stringers on the stabilizers are usually riveted to the skin sections in another department, this

Fig. 3. From the Assembly Lines Seen in Fig. 1, the Wings are Transferred to the Alignment Fixtures Here Shown, where Additional Webs, Bulkheads, and Skin Segments are Riveted in Place



practice having been found to speed up assembly operations in the final aligning fixture. A view of one of these fixtures is shown in Fig. 5.

Landing-gear oleo cylinders, pistons, and other component parts are delivered from the machine shop to a roller-conveyor assembly line to be assembled into complete landing-gear units. Curtiss-Wright engineers were first to adopt a roller conveyor for this work in aircraft production. Various stations along the conveyor are indicated by overhead signs. Progressive assembly takes place, from the fitting of the piston and cylinder to the running-in of the completed landing-gear unit.

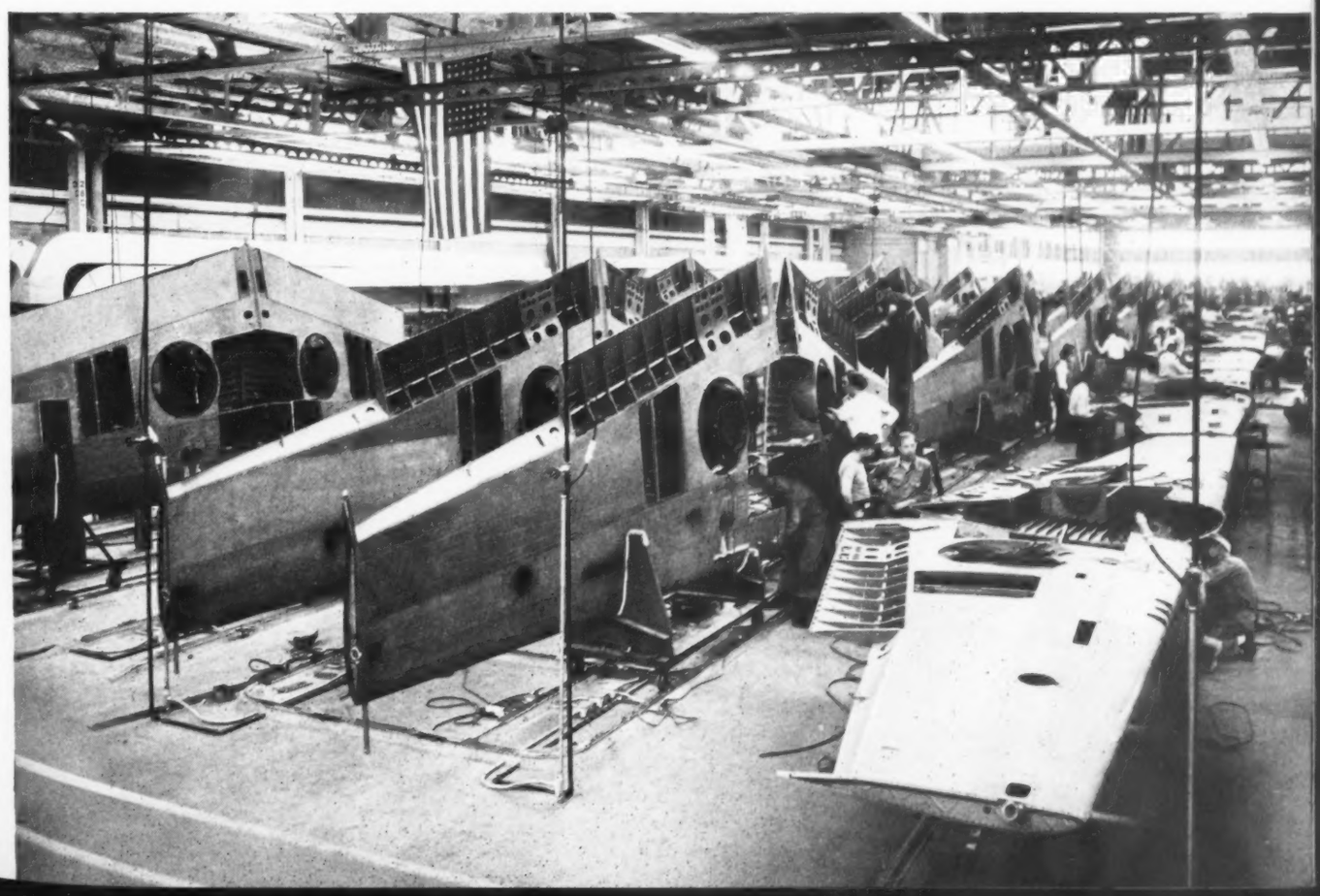
The primary construction of fuselages starts on mobile jigs, in which bulkheads are fastened in place and stringers are riveted longitudinally. By the use of Cleco clips, precut and dimpled skin is then attached and flush-riveted in place. These fuselages are fabricated in upper and lower halves. At the end of the assembly line, the lower half is placed underneath the upper half to make up the complete fuselage.

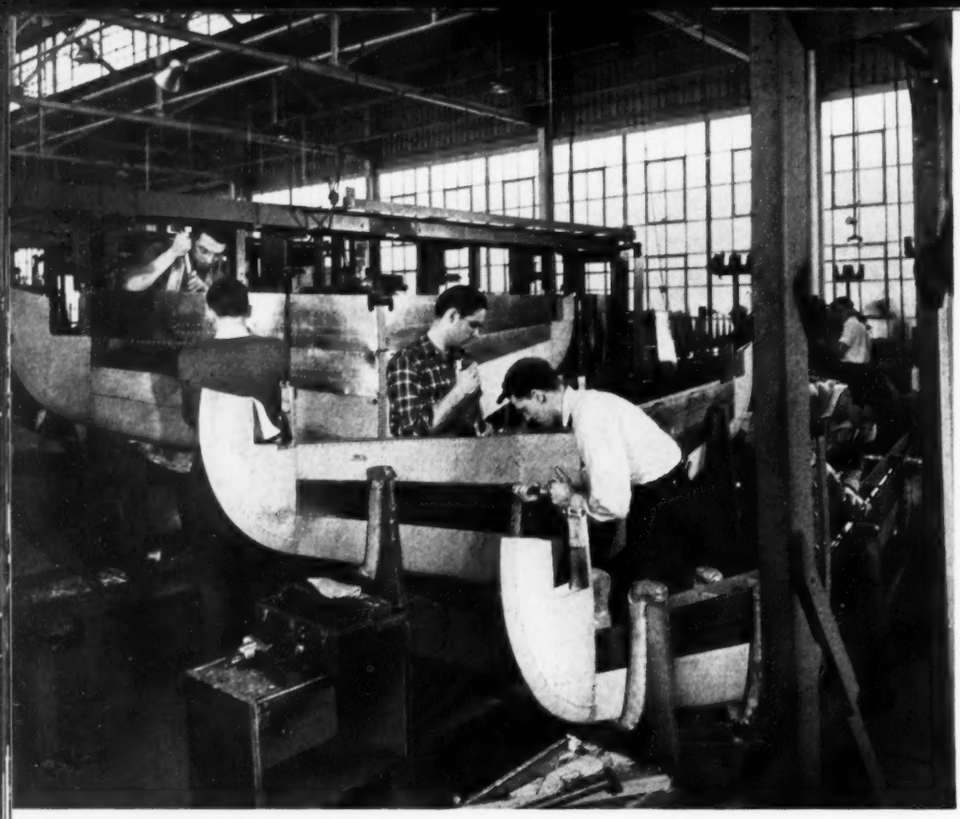
As the wings, engines, and fuselages progress along the final assembly lines, which are arranged in parallel, as seen in Fig. 6, sub-assemblies are supplied from other departments. The flexibility of production in this plant is indicated in Fig. 8, which shows a line of Curtiss Warhawks receiving such sub-assemblies as instrument panels and radio equipment, while, at the same time, huge C-46 cargo transports are having many miles of wiring and hydraulic lines installed. Tracks guide the fuselages to the successive stations along the assembly lines.

Upon the completion of the wing panel and the fuselage, these two sections are united in the line shown in Fig. 2, and the final connecting and inspection of functioning units takes place. The planes are finally lowered on their wheels and rolled out of the building for engine tests. Upon the satisfactory completion of these tests, which are made at all speeds, the planes are turned over to the Curtiss flight test section for shakedown flights.

Among the outstanding machines in the plant, which include multiple-spindle drills, gang punches, and special equipment for machining

Fig. 4. Assembly Lines in which the Wings Reach Their Final Stages of Fabrication. At the Right of the Illustration, Left and Right Panels are Seen being Trimmed to Obtain Even Contact





Curtiss-Wright

Fig. 5. (Left) Stabilizers are Built up by Assembly Methods Similar to Those Employed in Constructing the Wings

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Fig. 6. (Below) The Final Assembly Lines of Wings, Engines, and Fuselages Run Parallel to Each Other on One Side of the Factory Building

landing gears, is the 3000-ton hydraulically actuated Clearing press illustrated in Fig. 7, which is equipped with four work-tables, two at each end, that can be pushed transversely on tracks from loading positions at the right and left into line with the center of the press. While the tables are in their loading positions, forms of Masonite or steel plate are placed on the movable platens, and stamping blanks of duralumin are laid on top of the forms.

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After a loaded table has been pushed into line with the center of the press, a hydraulic mechanism on the table unit is operated to transfer its platen, with the load of forms and work blanks, into position on the press bolster. Heavy sheets of rubber bend the duralumin stamping blanks over the forms when the press ram descends. After the operation has been performed, the platen of work is returned automatically to its table and the latter is pushed back to the loading position. In the meantime, the press bolster has been reloaded from a table

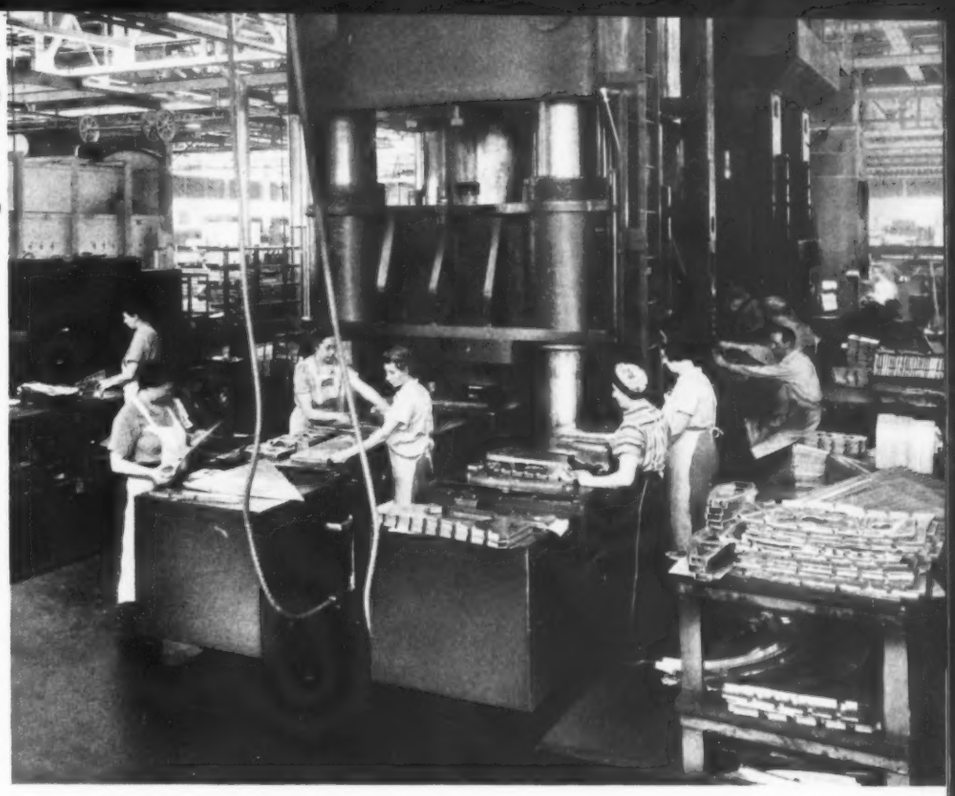

Fig. 7. (Right) Hydraulic Press Provided with Four Work-tables which Expedite the Forming of Duralumin Airplane Parts

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Fig. 8. (Below) Curtiss Warhawks Receiving Instrument Panels and Radio Equipment, and Cargo Transports Having Wiring, etc., Installed

unit on the opposite end of the press. The four tables enable the machine to be kept in constant operation.

Steel-faced wooden punches and dies are being used extensively in forming and drawing operations in this plant. Fig. 10 shows typical die equipment of this classification being used on a 750-ton hydraulically operated Clearing press for re-forming wing tips. It will be observed that the punch is constructed of three layers of wood, each layer being built up of sections that are screwed and glued together. The die member is also built up of layers of wood. The steel facing on both the punch and blank-holder is 1/8 inch thick.

In an operation, the partially formed wing tip is gripped firmly by the steel-faced surfaces of the punch and blank-holder as the press ram descends, the blank-holder being forced downward on its pins until the work-piece has been completely formed in the die. The blank-holder pins are supported on cushions.

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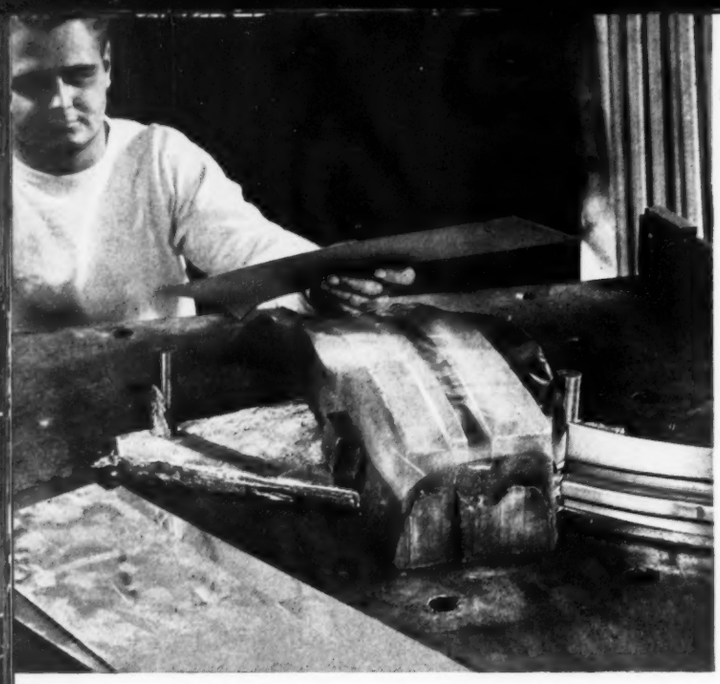

Fig. 9. The Use of Cellophane Enables Duralumin Parts to be Formed by Zinc and Aluminum Die Members without Any Marks being Produced on the Work

In some operations of this kind, airplane parts are redrawn to different depths by means of the same punch and die, pins of different lengths being provided on the blank-holder between successive draws in order to control the depth of draw. Annealing operations are, of course, necessary between redraws of the work. Safety of the helper on the press is assured by the fact that the operator cannot start the downward movement of the ram until the helper grasps two handles on his side of the machine similar to those seen above the operator. There is a third handle on each side of the machine by means of which the helper or the operator can instantly stop the ram movement in case of emergency.

Forming aluminum parts from ST stock is proving to be a profitable timesaver over forming the same parts from SO material. Examples of such parts are wing ribs or small bulkheads and other parts ranging from 0.020 to 0.064 inch thick, formed by all-steel dies, sheet-steel lined wooden dies, or by rubber. To bring the parts made from SO stock up to the required strength, it is necessary to heat-treat after the forming operations. This causes warping which makes from four to eight minutes of rework time necessary. The ST material is purchased in the heat-treated condition, and no rework time is required. In forming with ST stock, however, it is necessary to increase the radii due to the hardness of the material, recognizing, of course, that heavier material requires larger radii than thinner material. With ST stock it is also necessary to under-cut the die to allow for spring-back due to hardness, again taking thickness of stock into consideration. This means that the die is under-cut from 5 to 9 degrees to obtain a true 90-degree angle on the work. All open and closed angles are governed accordingly. Structural tests show that parts made from ST stock are stronger than parts that are made from SO material and heat-treated after forming. It

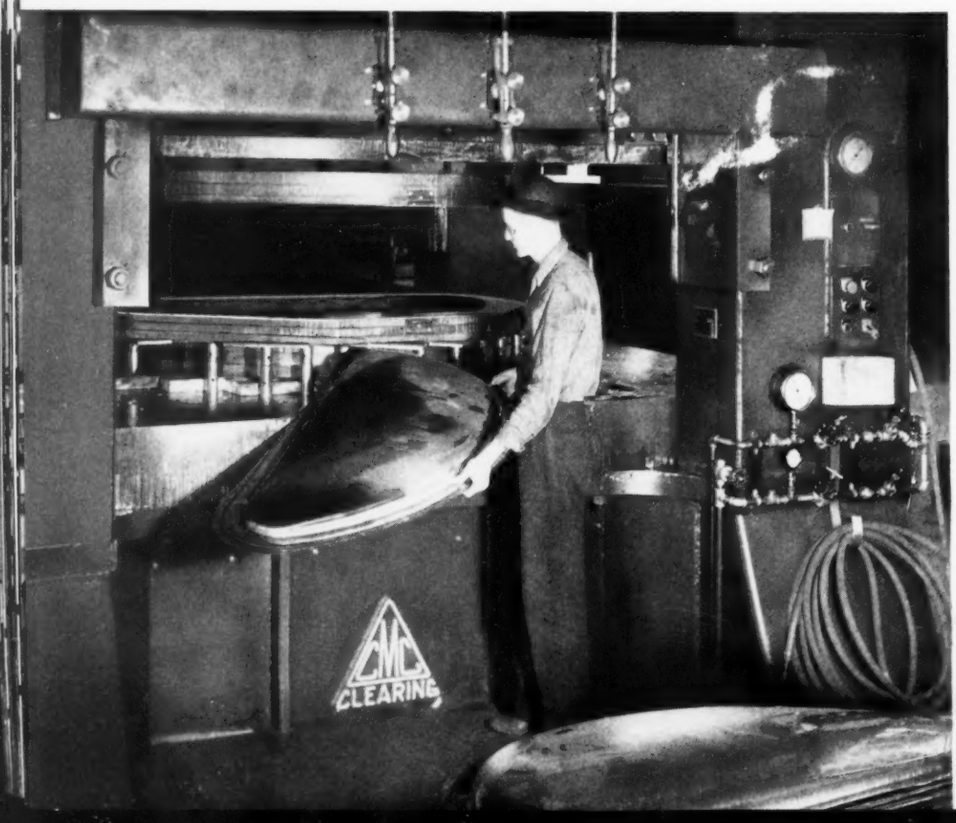

Fig. 10. Steel-faced Wooden Punches, Dies, and Blank-holders are Used in Forming and Drawing Operations on Duralumin Plane Parts

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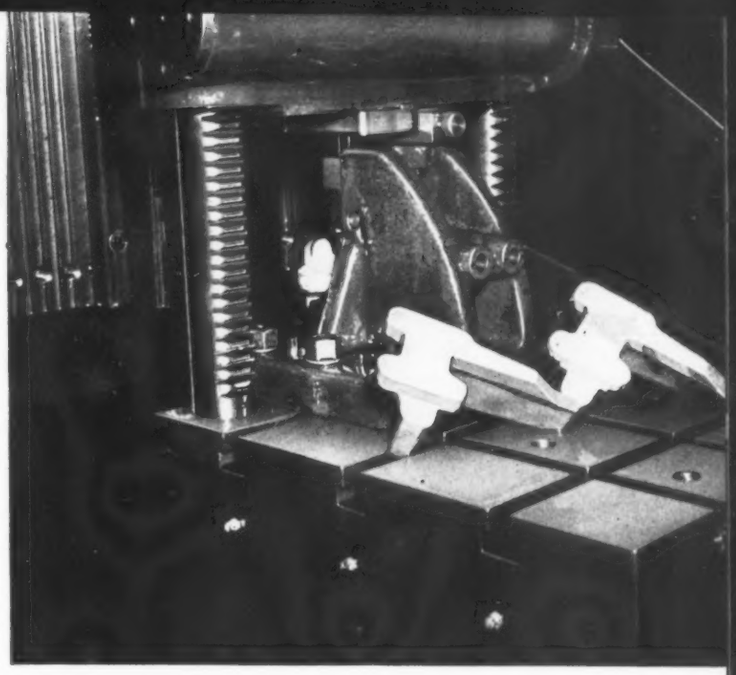

Fig. 11. Fixture Provided on a Vertical Broaching Machine for Finishing a Flat Surface on Landing-gear Cluster Fittings of Nickel-chromium-molybdenum Steel

has been found that stiffening beads formed by impressions previously incorporated in the die to reduce warping can be eliminated. Lightening holes can readily be produced.

In forming parts under hammers equipped with zinc or aluminum punches and dies, it is sometimes desirable to avoid producing marks on the work. Such marks can be prevented by applying cellophane to the punch and die members. In Fig. 9, for example, is shown a die on the bolster of a Cecostamp pneumatic hammer on which a piece of cellophane has been placed for this purpose.

In setting up the punch and die on one of these hammers, the punch is positively located on the press ram by the use of four keys, which engage cross-slots in the faces of the punch and ram. Then the punch is "spotted" on the die member, which has been placed on the bolster of the machine without being fastened. With the proper position of the die thus determined, molten lead is poured around it and large dowel-pins, as seen in the illustration, to hold it securely in that position. With large dies, the molten lead is sometimes poured between all sides of the die and bars mounted across the bolster. The bottom of all die members is machined to a smooth finish, which insures solid seating of the die and has been found to greatly increase die life.

Although approximately 30 per cent of the work on the Curtiss Kittyhawks and Warhawks has been sub-contracted to other shops, there is a machine shop of considerable size in this plant. Mass production methods such as were found only in shops of the automobile industry up to a few years ago are applied wherever possible. One of the outstanding machine tools which has greatly increased production rates over the method previously used is a Footburt 25-ton vertical broaching machine, a close-up view of which is seen in Fig. 11. The machine is shown set up for broaching landing-gear cluster

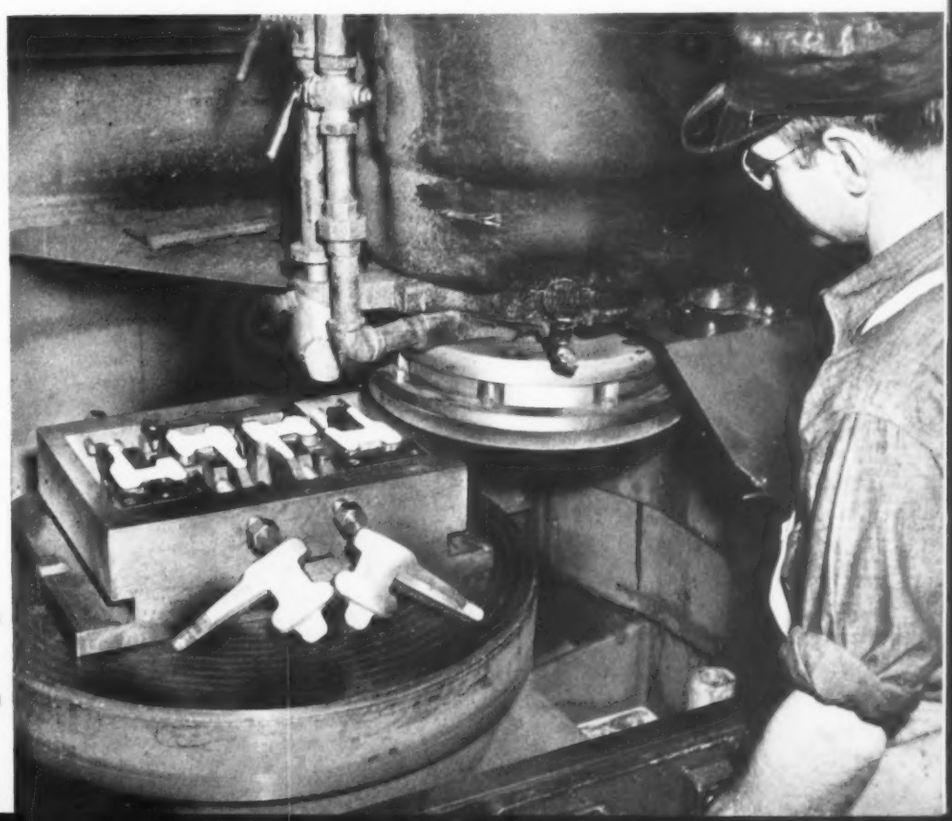

Fig. 12. Grinding the Flat Surface of Landing-gear Cluster Fittings on a Surface Grinder Equipped with a Special Fixture

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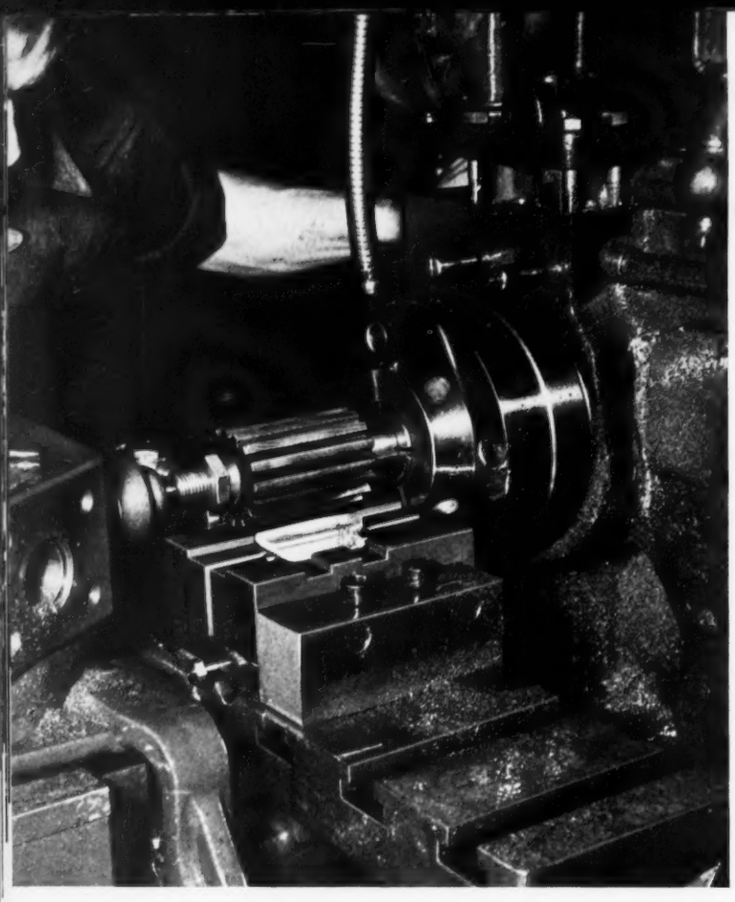

Fig. 13. Turret Lathe Set up for an Operation that would Ordinarily be Performed on a Milling Machine

fittings of nickel-chromium-molybdenum steel after they have been heat-treated to a hardness of between 32 and 36 Rockwell C. and a tensile strength in excess of 150,000 pounds per square inch. The production rate is almost seven times that formerly obtained by slab milling. Stock to a maximum depth of 3/16 inch is removed, and the work surface is finished flat within 0.001 inch.

The work-pieces are positioned, one at a time, between locating blocks on the front of a special fixture. They are clamped securely when the heavy cross-member extending across the top of the fixture is moved downward by turning a crank-handle. This action rotates pinions which engage rack teeth on the two posts that support the clamping cross-member.

After the fixture has been loaded and the operator pushes an electric switch button, the fixture moves forward into the working position, the broach ram descends to the bottom of its stroke, returns to its upper position, and the fixture returns to its loading position, all in automatic sequence. The table movement is approximately 18 inches. Both the table and the ram are actuated hydraulically. The broach can be used for a variety of flat work, as it is 6 1/2 inches wide. It is 5 feet in length.

The same parts may be finished from the rough by the Blanchard surface grinding machine illustrated in Fig. 12, equipped with a fixture that insures accurate seating of the odd-shaped parts, with the surface to be ground in a horizontal plane. Four parts, two right- and two left-hand, are loaded into the fixture at one time, and clamped against hardened and ground locating blocks by tightening cap-screws on two sides of the fixture. The time per piece is about 1/4 minute longer than the production rate of the broaching machine.

Sometimes it is necessary to apply machine tools to operations other than that for which they are intended, in order to relieve overloaded machines. Such an example is illustrated in Fig. 13, which shows a Gisholt turret lathe arranged for milling serrations across small nickel-chromium-molybdenum steel forgings. The forgings are located on a fixture which is mounted on the regular cross-slide of the turret lathe, and are fed under a multiple-tooth cutter of the thread milling type, which has teeth ground to the required form. This cutter is mounted on a mandrel which is gripped at one end in the collet chuck of the headstock, and held at the other end by a live center mounted on a turret face. The serrations are of true V-shape, and are milled to a pitch of 1/32 inch. The cutter is about 3 inches in diameter by 4 inches in length, and has sixteen flutes.

A second installment of this article will be published in a subsequent number of MACHINERY.

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NORTH AMERICAN SNJ-2 SCOUT TRAINER

Combat Trainers Swarm from Texas Plains

By H. F. SCHWEDES, Factory Manager
Texas Plant, North American Aviation, Inc.

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Fig. 1. (Above) Power-driven Final Assembly Conveyors in the Texas Plant of North American Aviation, Inc., which Deliver an Unceasing Flow of Combat Trainers, Ready for Test Flights

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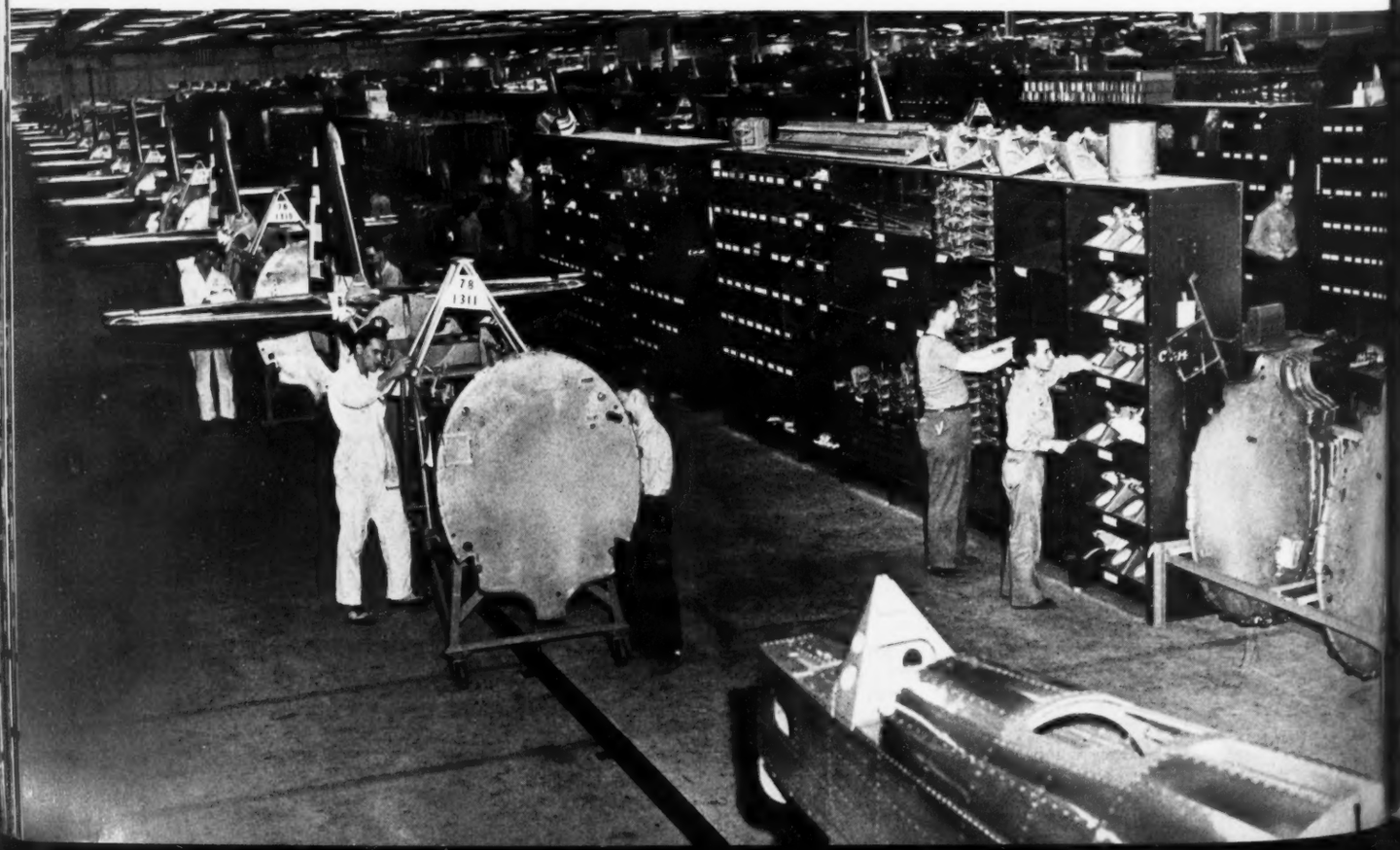
Fig. 2. (Below) View of One of the Fuselage Assembly Lines Showing the Arrangement of Bins on Both Sides of the Line for the Storage of the Various Units to be Assembled



Combat Trainers from Texas Plains

How Democracy has Risen to Meet the Axis Challenge is Typified by the Production Records of the New Texas Plant of North American Aviation, Inc., where 95 Per Cent of the Employes had No Previous Shop Experience—Ten Per Cent of the Workers are Girls

By H. F. SCHWEDES, Factory Manager
Texas Plant, North American Aviation, Inc.

WHEN unskilled help is to predominate in any manufacturing plant, it behooves the management to adopt the simplest methods that can be devised, consistent with production requirements. This was the problem that confronted production men in planning and equipping the combat trainer plant constructed by North American Aviation, Inc., a little more than a year ago "deep in the heart of Texas." There had previously been few metal-working industries in this locality, and it was therefore necessary to build a factory force (with the exception of a supervising nucleus taken from the Inglewood, Calif., plant of the company) from cow-hands, farmers, clerks, stenographers, college students, and even circus performers.

Approximately 95 per cent of the personnel had no mechanical experience prior to being hired in this plant. Ten per cent of the entire force are girls, and they have shown remarkable aptitude in learning to perform what were previously considered men's jobs. Girls have shown themselves especially skillful in electric-arc and oxy-acetylene welding, in riveting operations, in preparing the plaster molds for Kirksite dies, in the operation of light machine tools, and in the inspection of finished parts.

Before the plant was placed in operation, it was believed that scrap from defective work would run high, especially in the machine shop, and a schedule was drawn up prognosticating the monthly scrap for a period of three months. At the end of three months, this schedule was discarded, as the amount of scrap was amazingly low and in eight months, less scrap was being produced than in other plants which had been in operation for many years. This is especially

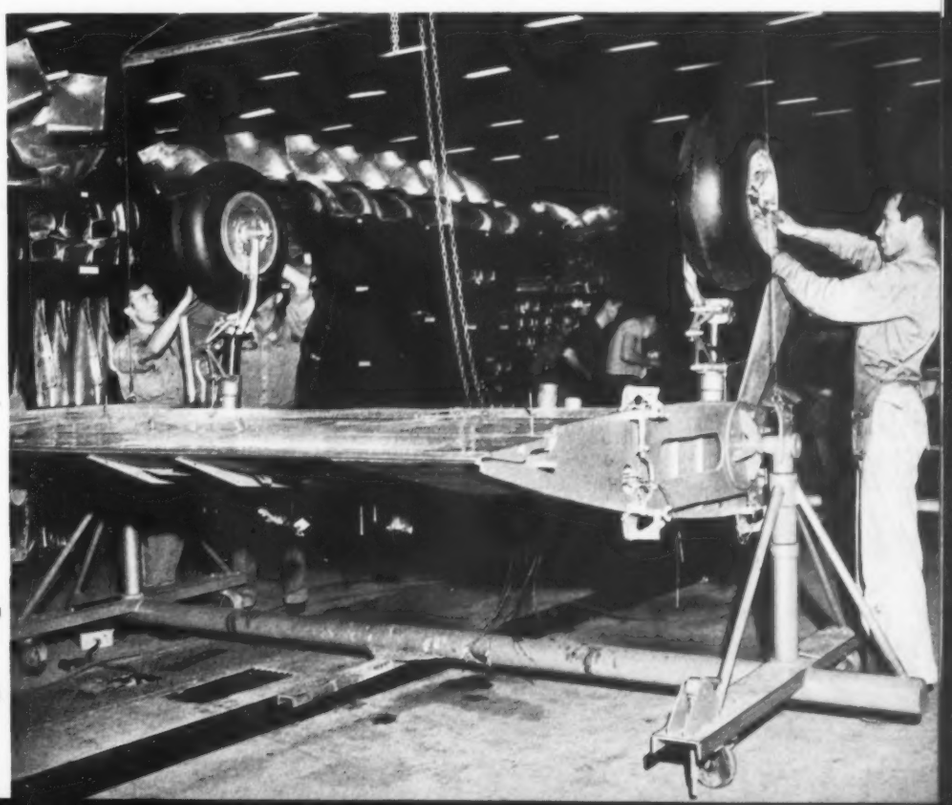


Fig. 3. Up to the Point where the Wheels are Assembled, the Center Sections are Carried upside down along the Conveyor Line. Then the Center Sections are Turned over and Proceed on the Plane Tires

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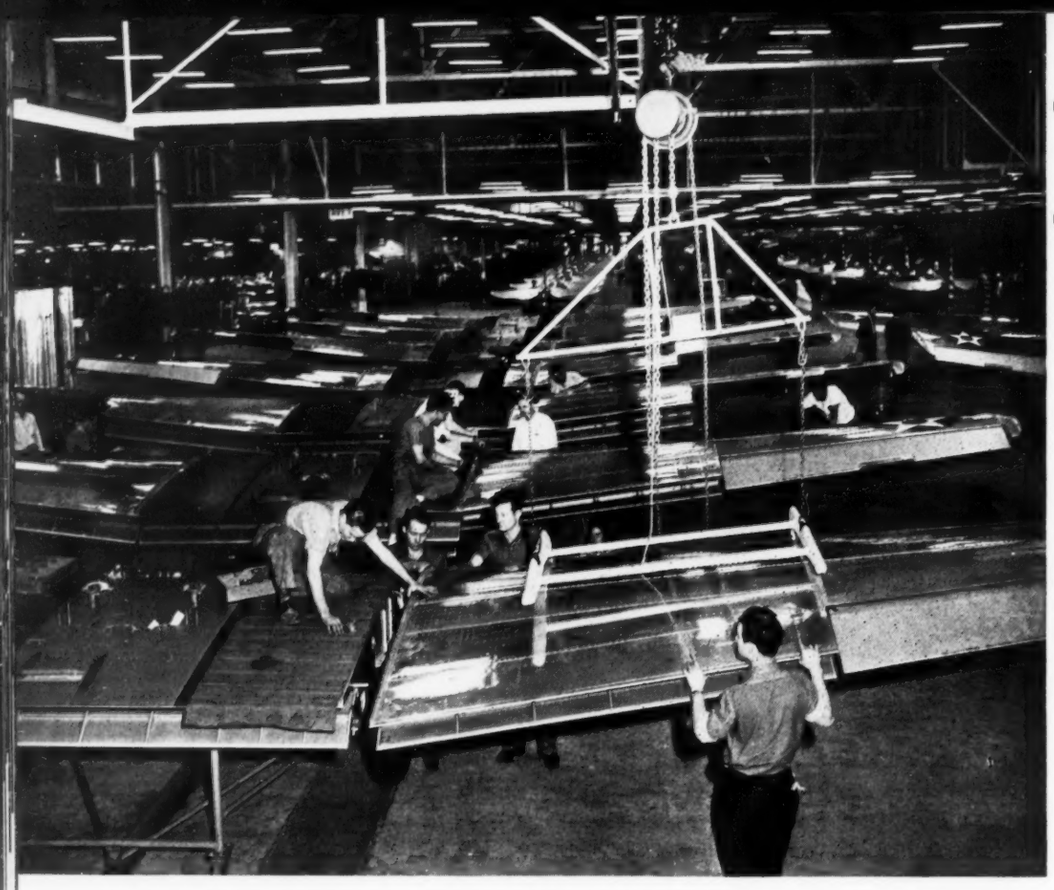

Fig. 4. The Center-section Assembly Conveyor Parallels the Final Assembly Conveyors, but Runs in the Opposite Direction

Fig. 5. Texas and Femininity are Emphasized in This Illustration, which Shows One of the Many Girl Workers in the Plant

surprising in view of the fact that the machine shop is practically self-sufficient in machining over 800 detail metal parts from forgings, castings, and bar stock.

Three combat trainers, built completely at this plant, were turned out within five months from the time ground was broken for the building. Since that time, the plant has remained consistently ahead of its contracted schedule of deliveries. One factor that has aided considerably in this achievement is the fact that the plant is completely air-conditioned for summer weather. The factory was laid out for directional flow of production from the receiving and storage departments at one end of the building through the manufacturing and sub-assembling departments to the final assembly lines.

Power-driven conveyors have been installed for the final assembly lines, for some of the sub-assembly operations, and for some of the manufacturing processes. Other power-driven conveyors are being installed for carrying castings, forgings, etc., from the receiving departments to the machine shop and then on to assembling operations, in the manner developed to such a high degree of efficiency by the automotive industry. These conveyors will be approximately 2400 feet long. Another conveyor 3000 feet in length will carry parts from the hydraulic presses to the heat-treating department and then to sub-assembly stations.

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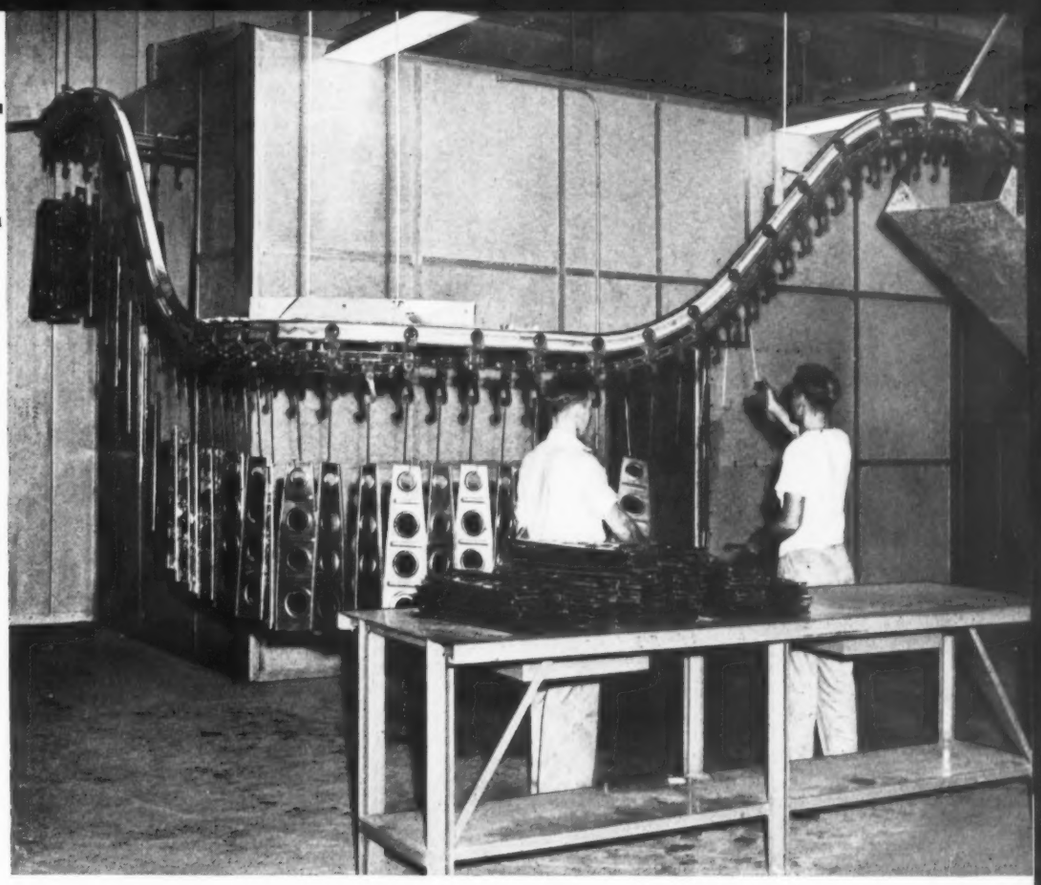
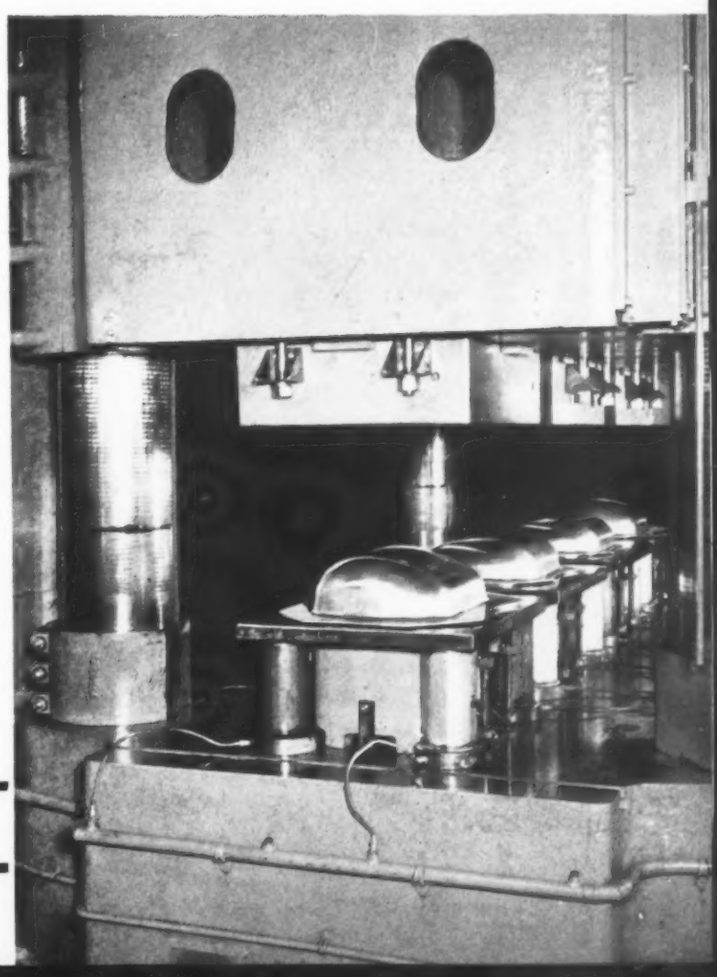


Fig. 6. One of the Overhead Chain Conveyors Installed for the Automatic Painting of Aluminum-alloy Stampings

There are separate conveyor lines in the final assembly department for the center section of the airplanes (including the wings) and for the fuselage. These conveyors run toward each other, and where they meet, the fuselages and center sections are transferred by an overhead monorail system to the final conveyors for assembling together. As the planes move along these final conveyors, the engines, instruments, and all other accessories are installed. The final assembly conveyors move constantly at a rate of speed that is held a close military secret. When the planes reach the ends of the final assembly lines, they are ready for test flights. A general view of these lines is seen in Fig. 1. The planes are finished when they pass under the American flag seen at the extreme right, and go out the raised doors.

The big advantage of constantly moving assembly lines is the mental effect on the workers. They endeavor to get their work finished before the planes advance beyond their stations. A view of the center-section conveyor is shown in Fig. 4 at the point where the wing panels are attached. Wheels are mounted on the center section just before the wings are lowered on it from overhead storage racks at one side of the conveyor line. Up to the point where the wheels are assembled, the center section is carried upside down on the trunnion carriage, as seen in Fig. 3. When the wheels have been attached,

Fig. 7. Multiple Dies Enable the Most Efficient Use of the 3000-ton Hydraulic Presses in This Factory



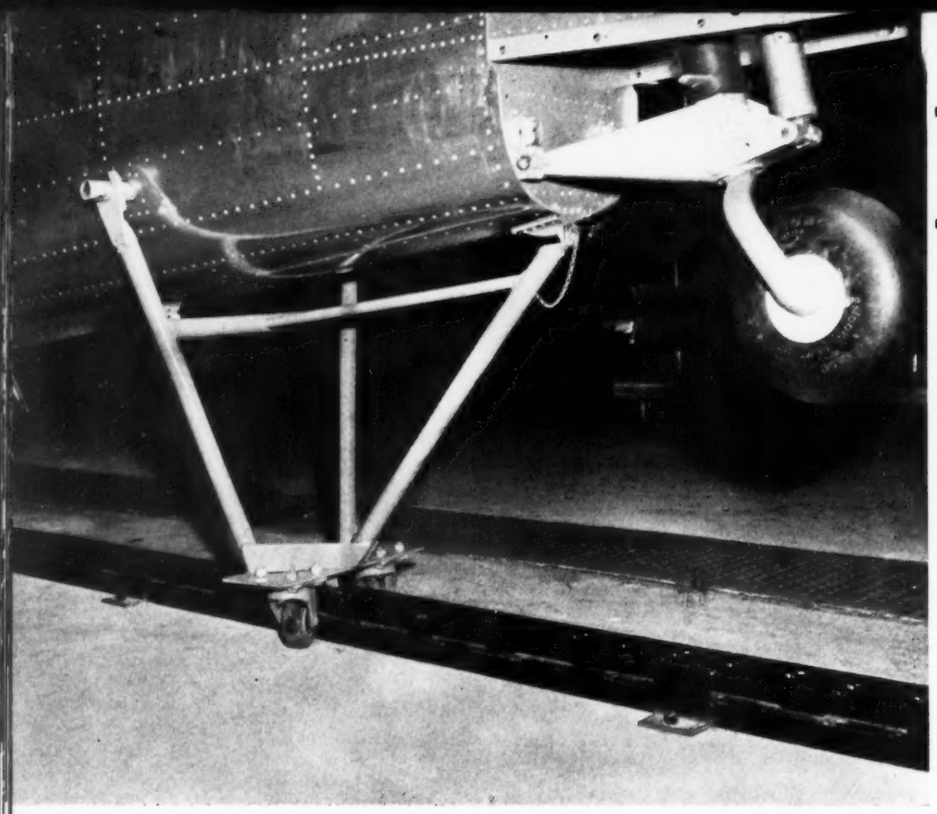


Fig. 8. The Nose End of a Plane on the Final Assembly Line, Showing how the Plane is Supported and Pulled along

the center section is turned completely over on the carriage, and from then on, the center section is pulled on its own wheels rather than on the carriage. One center-section assembly line meets the needs of three fuselage conveyors and two final assembly conveyors.

One of the fuselage conveyors is seen in Fig. 2. This illustration shows how bins of the parts to be assembled extend along the conveyors. All parts are neatly stored in the bins, requiring minimum floor space, and are located right at the stations where they are to be assembled to the passing fuselages. Power tools for use in the assembly operations are suspended from overhead, so as to keep the floor clear. It will be noted that on both the fuselage and final assembly conveyors, the planes are pulled along backward, because they "track" better that way than when they are drawn frontward. The type of small truck that is connected to the link-chain conveyors of these assembly lines to pull the planes along, is shown in Fig. 8.

In Fig. 6 is shown a conveyor installed for other than assembling operations. This conveyor carries small and medium-sized duralumin stampings through a zinc-chromate dip. The parts are automatically dipped into the tank of zinc-chromate, which is installed in the

Fig. 9. Multiple-impression Dies Enable Several Operations to be Performed on the Same Part in One Machine

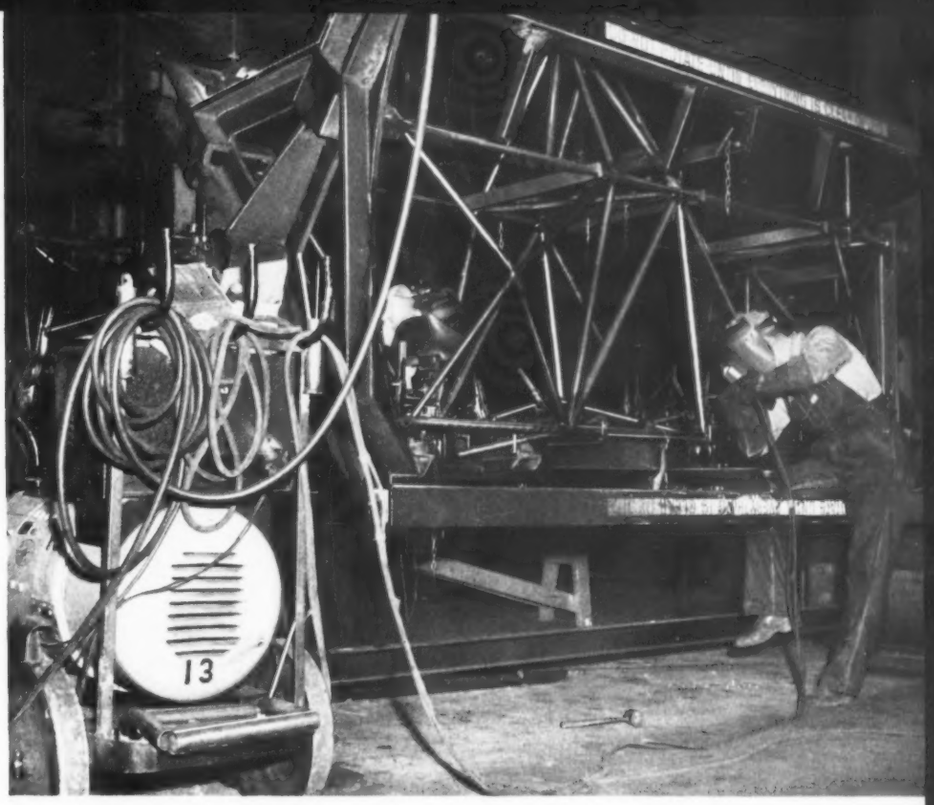


Fig. 10. Trunnion Jig Used in the Fabrication of the Fuselage Frames, which is Accomplished Entirely by Arc Welding

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closed-in compartment seen in the illustration. They are also automatically raised from the tank and discharged from the conveyor line as they strike the chute seen at the extreme right. Two men or girls keep the conveyor loaded.

In all machine operations, the effort is made to utilize equipment in the most efficient manner. On the hydraulic presses, for example, unless the work is large enough so that the die occupies approximately the full area of the press bolster, a multiple number of dies is set up. In Fig. 7 is shown a typical set-up, there being four dies on the press bed and a similar number of punches on the ram of the machine.

Each of the dies is provided with a blank-holder or pressure-plate which is supported at the four corners by hydraulic jacks. When the press ram descends, the four blanks to be drawn are gripped securely between these blank-holders and the faces of the punches to insure the production of smooth work to the desired contours. The four dies illustrated produce two different parts.

In the operation of Cecostamp pneumatic hammers, an effort is always made to use at least the minimum die area recommended by the hammer builder. It is the custom to use several Kirksite dies of the same or separate types

Fig. 11. Wear on the Wheels of Disk Grinders has been Reduced by Providing a Uniform Flow of Water over the Wheel

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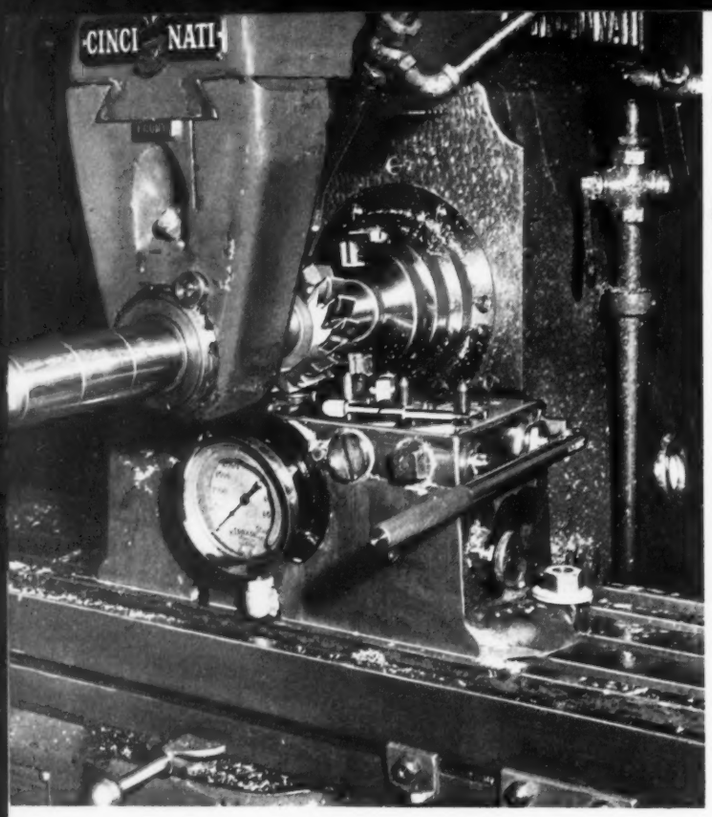

Fig. 12. Hydraulic Chuck Designed for Milling Machine Operations, which Enables Six Pieces of Work to be Instantaneously Clamped or Unclamped

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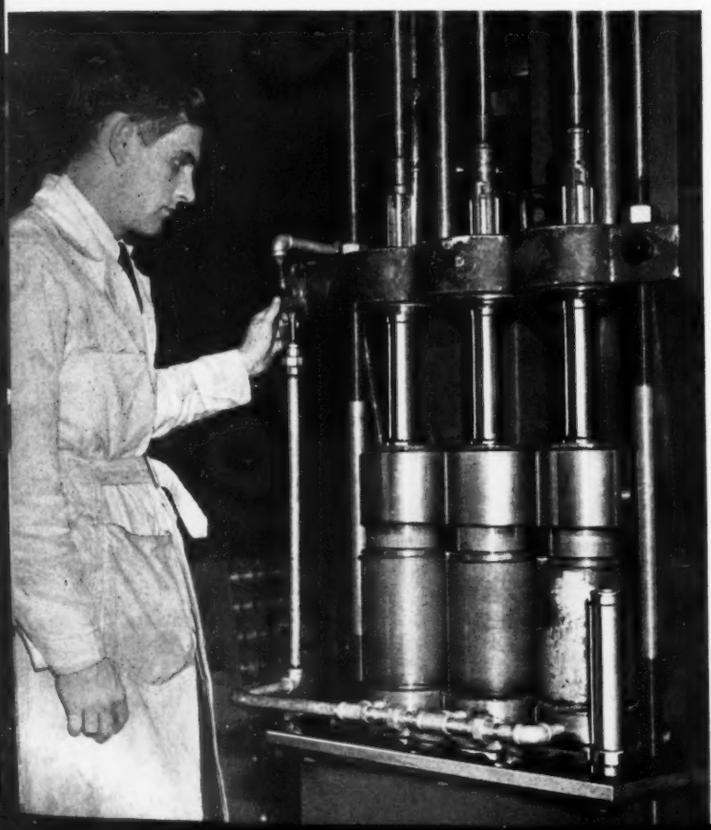
Fig. 13. Three-spindle Honing Machine Equipped with Hydraulic Jacks for the Rapid Clamping of Strut Cylinders



in many operations. In some instances, where successive operations are required on the same part, a multiple-impression punch and die, such as seen in Fig. 9, are provided. The sheet-metal work-piece is successively transferred from impression to impression, as in drop-forging practice.

Electric arc welding has been substituted for the oxy-acetylene process in all welding except that performed on parts of stainless steel, such as heaters and exhaust stacks. The various members that make up the fuselage frame are arc-welded in simplified units of two or more pieces, and then brought to jigs such as shown in Fig. 10, where the entire frame is welded into a complete assembly. This jig can be rotated to bring all parts of the fuselage frame into a convenient welding position. Wilson "Hornet" welders of 200-ampere rating, equipped with Stroco crater eliminators, are used. The tubing is of chromium-molybdenum steel.

Practically all of the arc welding preparatory to the operations in the final jig is performed by girls who have been taught welding in a course developed by the foreman of the department. This course has turned out finished welders in as short a period as thirteen days, while twenty days of training may be considered the average.

Ingenious ideas applied in the machine shop have paid large dividends in the way of economical production, and have facilitated the output of accurate work by unskilled help. One simple idea has effected a large saving in the wear of the abrasive wheels on disk grinding machines. These grinders are provided with a pipe, as shown in Fig. 11, which extends to almost the center of the machine. Originally, the pipe was plugged shut at the end near the center of the machine, and provided with a series of holes along its length from which water was sprayed on the abrasive disk when operations were in progress. With this arrangement, the abrasive disk had to be dressed three times a day.

By the simple expedient of plugging shut the spray holes and opening the end of the pipe, so as to deliver a full flow of water to a recess in the center of the abrasive disk, the dressing of wheels has been reduced to only once a week. A sheet-metal cap, such as shown in the illus-

tration, was installed in the center of the machine to cause the water to fall into the recess, from which point it is distributed uniformly to the periphery of the disk by centrifugal force. The pieces of work never become hot. Gardner disk grinders are used.

In Fig. 12 is shown a milling machine equipped with a hydraulic chuck devised to facilitate holding parts such as seen lying on top of the chuck while they are being straddle-milled on the head end. Six parts can be loaded at one time in collets assembled in this chuck, with the stems of the work inserted vertically in the collets. The work-pieces are securely clamped when the handle at the right-hand end of the chuck is moved to open a valve. Hydraulic pressure is then applied to move a piston-rod horizontally beneath the collets. The bottom end of the collet shanks rides on angular cam surfaces on the piston-rod in such a way that the collets are made to move downward and their jaws tightened on the work when the piston-rod is moved in one direction. The collets are raised and their jaws opened up when the piston-rod is moved in the opposite direction. The collets are changeable to suit work of different diameters.

Hydraulic jacks are provided on the Barnes three-spindle honing machine shown in Fig. 13 to speed up the loading and unloading of strut cylinders, which are the small-diameter tubes seen above the jacks. The heads of these jacks are counterbored on top to provide sealed seats for the lower ends of the strut cylinders, and the bushings in the bracket above the strut cylinders are likewise counterbored to receive the upper ends of the cylinders. The jack heads are also bored for the required distance to enable the hones to pass through the strut cylinders.

In an operation, the strut cylinders are placed on the jack heads and instantly gripped between the jacks and the overhead bushings by the application of hydraulic pressure in the cylinders below the jacks. The strut cylinders are honed to the specified diameter within a tolerance of plus or minus 0.001 inch for a length of approximately 9 inches. The jack heads and the hone bushings can be readily changed to suit work of larger or smaller diameter.

The use of Carboloy-tipped fly cutters for the machining of aluminum-alloy castings is being

Fig. 14. The High-speed Finishing of Plane Surfaces has been Facilitated by the Use of Fly Cutters, Mounted on Fairly Heavy Disks and Run at High Speed

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Fig. 15. Another Fly Cutting Operation in which Use is Made of a Stepped Cutter having Two Carboloy Tips

Fig. 16. Broaching Two Holes in Selector Valve Bodies to the Specified Diameter within a Total Tolerance of 0.0003 Inch

employed with particularly satisfactory results. In Fig. 14 is shown a Sundstrand Rigidmil, set up with four cutters of this type spaced around a disk 10 inches in diameter. At a spindle speed of 2400 R.P.M., a surface cutting speed of approximately 6300 feet per minute is obtained. Stock to a depth of 1/4 inch is taken off by the three roughing tools and one finishing tool at a feed of 30 inches a minute.

The tools are positioned at slightly different radii from the center of the cutter-head, and they extend slightly different heights from the face of the head. The operation finishes the pad that extends up the left-hand side of the part (as seen on the right-hand end of the table), as well as the pad that extends across the upper end of the same side, and the small pad in the lower right-hand corner. The pad surfaces are, of course, all in one plane, and this plane must be held within 0.0003 inch of a specified distance relative to holes previously machined in the casting. The cutter-head was made purposely heavy to insure smooth running.

Another operation on the same part, shown in Fig. 15, involves the use of a two-step fly cutter with two Carboloy tips. This tool simultaneously cuts the top of a flange flat for a width of about 1/8 inch at an angle of 45 degrees to form a bevel, and also straight down for a width of 3/4 inch and to a depth of 1/8 inch. In this operation also, the cutter-spindle is run at 2400 R.P.M., and as the distance from the center of the spindle to the outer cutting edge is 3 inches, the surface cutting speed of this edge is about 3800 feet per minute. The feed is 30 inches a minute.

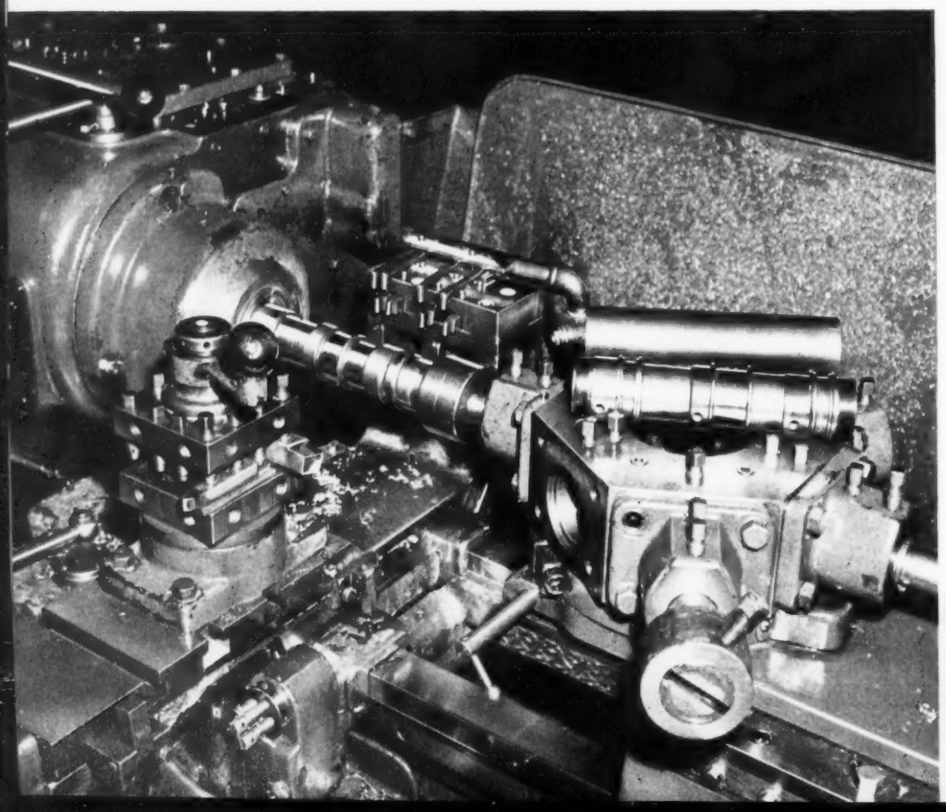

Fig. 17. Turret Lathe Used for the External Machining of Flap Cylinders from Pieces of Tubing to the Contour Indicated by the Example on Top of the Hexagon Turret

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Fig. 18. Spacing Blocks on the Column of Multiple-spindle Drilling Machines Enable High or Low Jigs to be Used

Through the use of machining methods of this kind, the time required for completely finishing the casting shown has been reduced to less than one-sixth the time previously consumed with conventional milling methods. The fly cutting principle has also been applied to vertical-spindle milling machines.

A broaching operation in which two holes are finished in selector valve bodies to a diameter of 0.500 inch within plus 0.0003 inch, minus nothing, for a length of 8 1/2 inches, is shown in Fig. 16. In addition to this accuracy as regards the diameter, the holes must be closely parallel. The operation is performed on an Oilgear, 35-ton hydraulic broaching machine, stock being removed to a depth of 0.0075 inch per side of the holes. White lead is brushed on the broach between operations. The castings are of aluminum alloy.

A Jones & Lamson turret lathe set up for a heavy-duty operation on flap cylinders is shown in Fig. 17. These cylinders are produced from lengths of chromium-molybdenum steel tubing which come to the machine in the form shown at the back of the hexagon turret. When the parts leave the machine they look like the finished piece at the front of the turret, except for the threaded ends and the holes drilled through the body. In the turret lathe operation, the tubing is first turned the full length by applying a tool on the square turret at the front of the cross-slide. Then a circular form tool on the square turret cuts a groove near each end of the tubing.

The four gang cutters at the rear of the cross-slide are next advanced for cutting to reduced diameters for various widths, leaving narrow shoulders. A tool on the square turret is finally applied for facing one of the shoulders to a sharp corner on the inside, so as to obtain a bearing surface that must be of the specified width within a close tolerance. The cutters on the square turret are all Carboloy tipped, while those at the back of the cross-slide are of high-speed steel.

Multiple-spindle drilling of jigged parts is widely applied in the machine shop. In Fig. 18 is shown a battery of Natco machines of the multiple-spindle type used for a variety of work that ranges considerably in size. When parts are being handled that require a comparatively high jig, a hollow spacing block is interposed between the top of the column and the bottom of the drill-head gear-case, as shown, so as to increase the maximum height between the top of the table and the bottom of the drill head. Special tubes must also be provided for the telescopic drill spindles to increase their length. When low jigs are being handled, the spacing block can readily be removed, the gear-case then being supported directly on top of the column. The spacing block is about 12 inches high. Spacing blocks have been provided for practically all the machines in this battery.

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BOEING B-17E FLYING FORTRESS

Boeing Builds Flying Fortresses to Bomb the Enemy

By CHARLES O. HERB

FLYING Fortresses developed by the Boeing Aircraft Co., Seattle, Wash., for the United States Army Air Corps during the last seven years have proved a key weapon in the forces of the United Nations. They have rendered spectacular service in the Far East against the Japanese, and also in daring raids on German shipping points and objectives in Nazi-occupied Europe. It was a Flying Fortress that sank the Japanese battleship *Haruna*, and a squadron of these four-engined bombers successfully conducted the first sub-stratosphere daylight attack on the European continent at an altitude of 35,000 feet.

The Flying Fortresses of today are far more powerful than those of pre-war days, as they have been substantially improved to meet the conditions of present warfare. Some of the new

features are shrouded in secrecy for obvious reasons, but the War Department permits reference to the power-operated gun turrets on the top and bottom of the fuselage, and the deadly "stinger" turret in the tail. This modified model B-17E Flying Fortress has been in such great demand by our armed forces that the Government ordered several aircraft concerns other than the Boeing Aircraft Co. to produce them. This article, however, will deal exclusively with typical manufacturing operations in one of the recently built Boeing factories. Production schedules are now closely guarded military information, but it may be mentioned that they have been greatly accelerated during past months, in line with President Roosevelt's demands for unprecedented aircraft production.

The production of Flying Fortresses has been expedited considerably through a revised method of final assembly. The forward and tail sections are now sub-assembled in separate jigs, instead of being put together in one jig. This procedure enables many more men to be employed at one time in assembling operations on the same plane, and allows more efficient use of the available manufacturing space. Each of the fuselage jigs is duplicated many times, as will be apparent from Fig. 1, which shows rows of forward or nose sections on wheeled cradles on the assembly floor, right after they have been taken from the jigs seen in the rear. The tail sections and wings are sub-assembled in adjacent rows of jigs. Sections are carried to the final assembly department by means of overhead cranes for assembling into complete bombers. The wings are fabricated vertically in jigs, with the nacelles hanging downward, which enables a large number of jigs to be located close together in a comparatively small floor space. The height of the wing jigs is such that three tiers of platforms are necessary to allow the workmen to reach all sections conveniently.

A change from former manufacturing practice is the exclusive adoption of multiple-action

Fig. 1. Forward Half of Flying Fortress Fuselages along Assembly Lines where Instruments, Accessories, and Wiring are Installed, Ready for Assembly of Wings and Tail Section

Fig. 2. (Left) Double-action Punch and Die Employed in a Hydraulic Press for Blanking and Forming a Fuselage Part

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Fig. 3. (Below) Operation in which a Part is Drawn to a Depth of About 10 Inches for a Length of 18 Inches in One Stroke of the Press

hydraulic and mechanical presses in place of drop-hammers of the rope- or air-operated types for forming and drawing the multitude of sheet-aluminum and stainless-steel parts required in aircraft building. Triple-action presses provide for the use of a blank-holder and a vertical movement of the bottom die member after the press ram has descended its full amount.

Fig. 2 shows a close-up view of a 750-ton Clearing hydraulic press equipped with a punch and die for a forming and blanking operation on a fuselage cab detail. Double action is utilized to grip the work-piece securely all around its edges between the die and a blank-holder on the ram, and then to perform the forming and blanking operations. In Fig. 3 is seen a 300-ton Clearing hydraulic press being used for drawing a stainless-steel piece to a depth of about 10 inches for a length of approximately 18 inches in one stroke of the press. This is also a multiple-action operation.

Two aluminum-alloy pieces, to be used as cab window frames, are formed simultaneously with the single-action cushioned operation of the punch and die seen on the 500-ton press in Fig. 5. In all the operations illustrated, the punch and die main members are made of Kirksite.

An unusual piece of equipment which has been jokingly termed the "octopus" is illustrated in Fig. 4. This machine was developed to punch holes through circumferential stiffeners. It consists essentially of nineteen small punch presses operated by Logan air cylinders, which are located around a semicircle on individual clamping bars that radiate from the operator's position. The punch units can be positioned at any radius on the bars to suit the work. Each punch press has a spring-backed pressure plate, which is moved downward under the action of the air cylinder to hold the work securely while the ram continues downward and cuts the hole. After the stiffener has been loaded

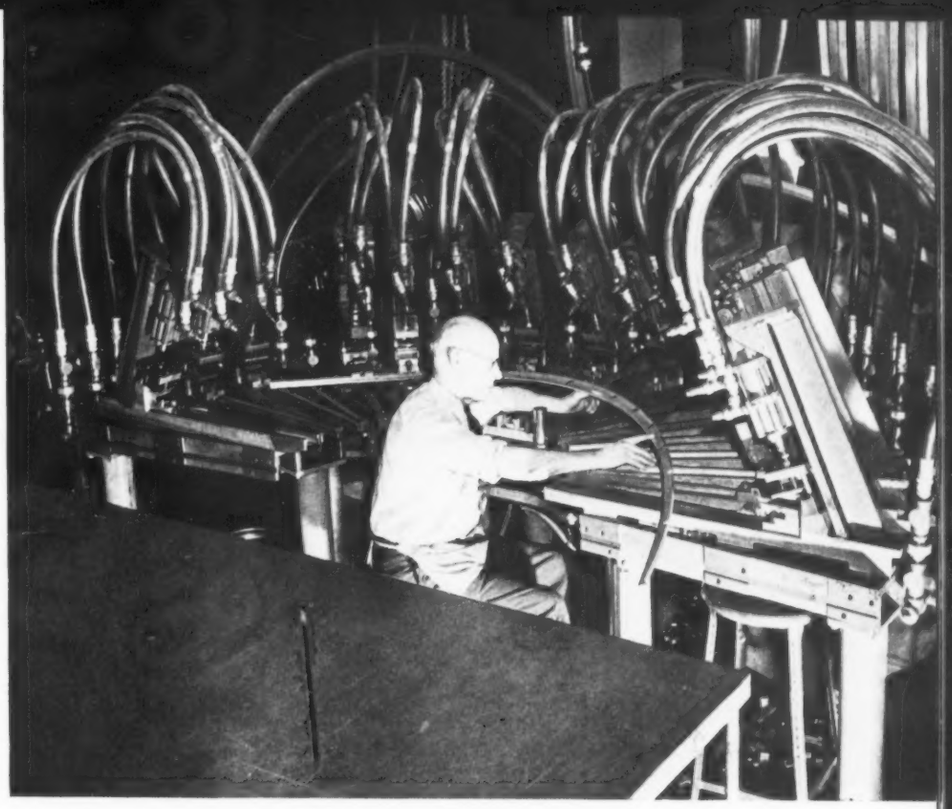

Fig. 4. (Right) Machine Constructed of a Multiple Number of Small Air-operated Presses for Punching Holes in Circumferential Stiffeners

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Fig. 5. (Below) Hydraulic Press Operation in which Two Pieces of Duralumin are Bent into Cab Window Frames

into the machine, the operator holds it in position by hand and leans against a curved wood bar which, in turn, operates a switch and solenoid devices that control the air supply.

In addition to punches, these presses can be provided with shear blades for cutting the stiffeners to the required length. Stops locate the ends of the stiffeners to insure accurate location of the different holes. As many or as few presses as desired can be operated by merely turning corresponding air valves on or off.

Many duralumin sheet-metal pieces are stretched to the required shape on Erco stretching machines. Fig. 6 shows one of these machines being used to simultaneously stretch two pieces, about 16 inches wide by 4 feet long. Both ends of the sheets are gripped by air-operated clamps on opposite sides of the machine after the sheets have been extended across Kirksite forms on the table. Then the table is raised through the operation of hydraulic cylinders until the yield point of the material has been exceeded, so that the parts will retain their shape when released. In the operation shown, the parts are formed to a compound curvature. Stretching operations of this type are facilitated by brushing the Kirksite forms with ordinary No. 20 automobile lubricating oil. The machine shown in the illustration has a capacity of 75 tons.

When wider sheets are to be handled, additional clamps can be provided. The clamping jaws can be set at an angle longitudinally to permit handling sheets of material of tapering widths.

In Fig. 7 is shown a similar Erco stretching machine of 300 tons capacity, which is ordinarily used for operations similar to the one being performed in Fig. 6, but which is shown being used for stretching long pieces of rolled hat section. The ends of the hat sections are gripped in clamps mounted on angle-iron supports that extend across the machine.

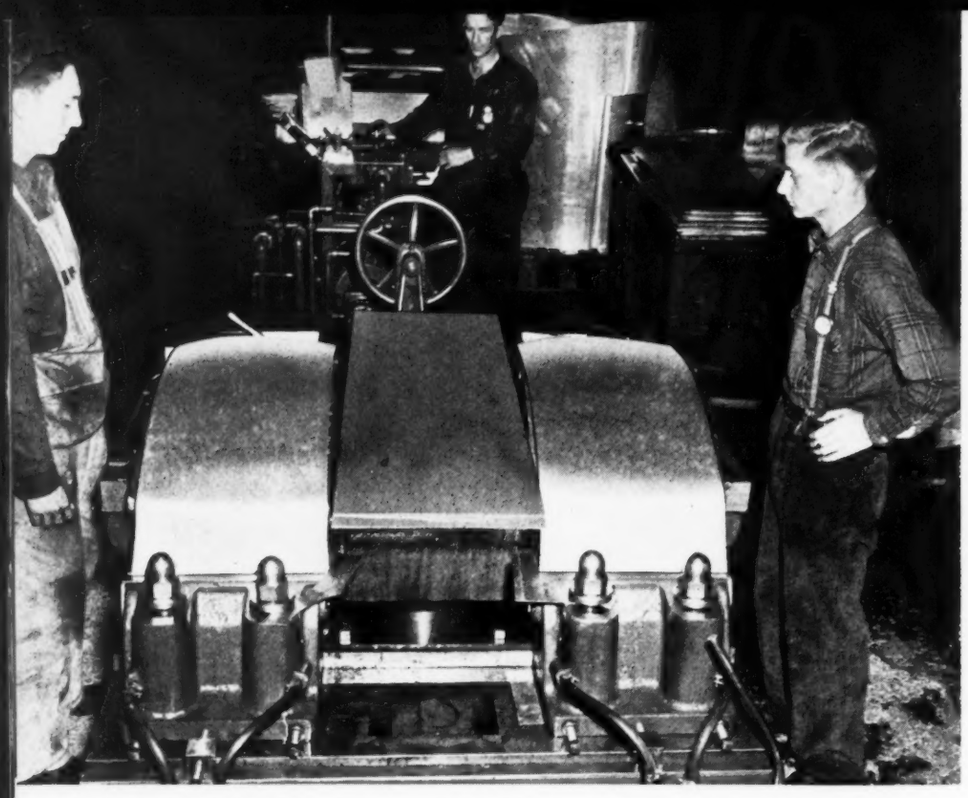

Fig. 6. Stretching Two Duralumin Sheets to Radii, Both Longitudinally and Crosswise, in a Machine of 75 Tons Capacity

At the beginning of an operation, the hat section is straight, as seen in Fig. 8, which shows the machine set up for stretching two hat sections at one time. When the work-table is raised, toggle links impose an initial load on the section to stress the flanges along the bottom of the work beyond their yield point. Then, as the Masonite forms come up under the sections and bend them to the required radius, the hat sections are shaped smoothly. Without the initial stressing, wrinkles or buckles along the flanges could not be avoided. The table is raised far enough to stretch the material sufficiently so that there is no spring-back when the parts are released from the machine. Strips of wood are placed in the hat sections prior to the stretching operation to prevent "necking in" or narrowing of the sections. Forms up to 7 1/2 feet long by 8 feet wide can be used on this machine in the type of stretching operation for which it is specifically designed.

Skin sheets for covering the wings are "sewn" together by spot-welding machines whose operation is synchronized with automatic spacing tables that advance the skin sheets in the required increments beneath the welding electrodes. Fig. 9 shows a Sciaky welding machine engaged in an operation of this kind. The sheets

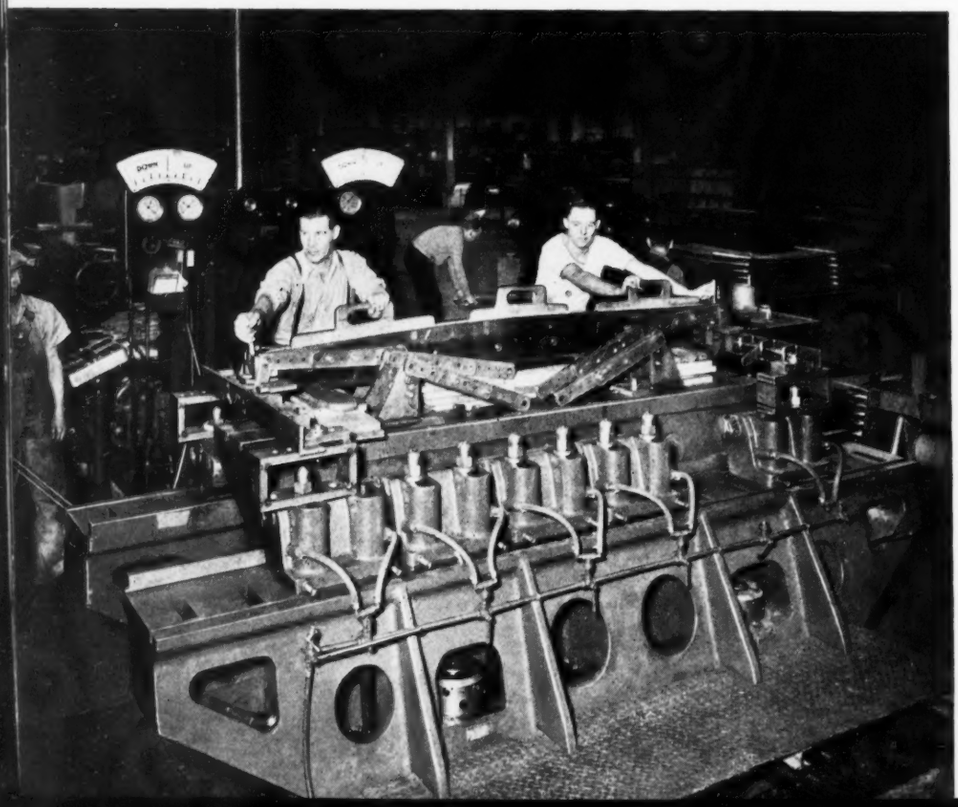

Fig. 7. Special Tools Used on a Stretching Press for Curving Hat-section Aluminum Strips to a Large Radius

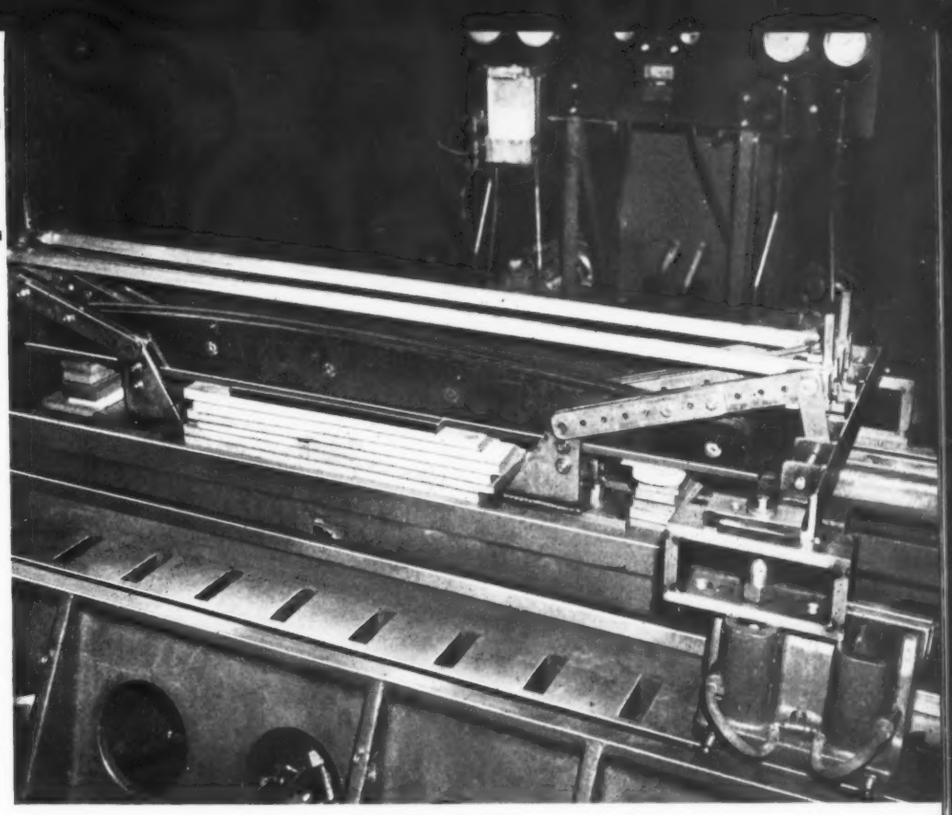

Fig. 8. Close-up View of Operation in Fig. 7, which Shows the Toggle Links that Place an Initial Stress on the Work prior to Forming

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to be joined by spot-welding are held on the table in the proper relation to each other by means of magnetic clamps. The spot-welds are spaced 1/2 inch apart. Each time the table stops, the welding electrode is brought down on the sheets being joined together. As many as eight sheets of skin are welded together, the skin sheets for wings ranging up to 26 feet long by 9 feet wide. The spacing tables are 12 feet wide and somewhat longer than 26 feet.

Maximum life of the electrodes on the spot-welding machines has been attained through the provision of a Frigidaire cooling system. Coolant from the compressor of this unit is delivered through piping and hose directly to the electrodes of the individual machines, as seen in the illustration.

One of the operations of particular interest in the machine shop is the grooving of Glycol heaters, as seen in Fig. 10. This operation is performed on a Warner & Swasey turret lathe. The grooves are produced by fifteen roughing cutters of narrow width at the front of the cross-slide, and a like number of finishing cutters at the back. Thirty grooves are cut in each part to a width of 0.100 inch. All but the six grooves at the head end are machined to the same depth, or to a root diameter of 1 3/16

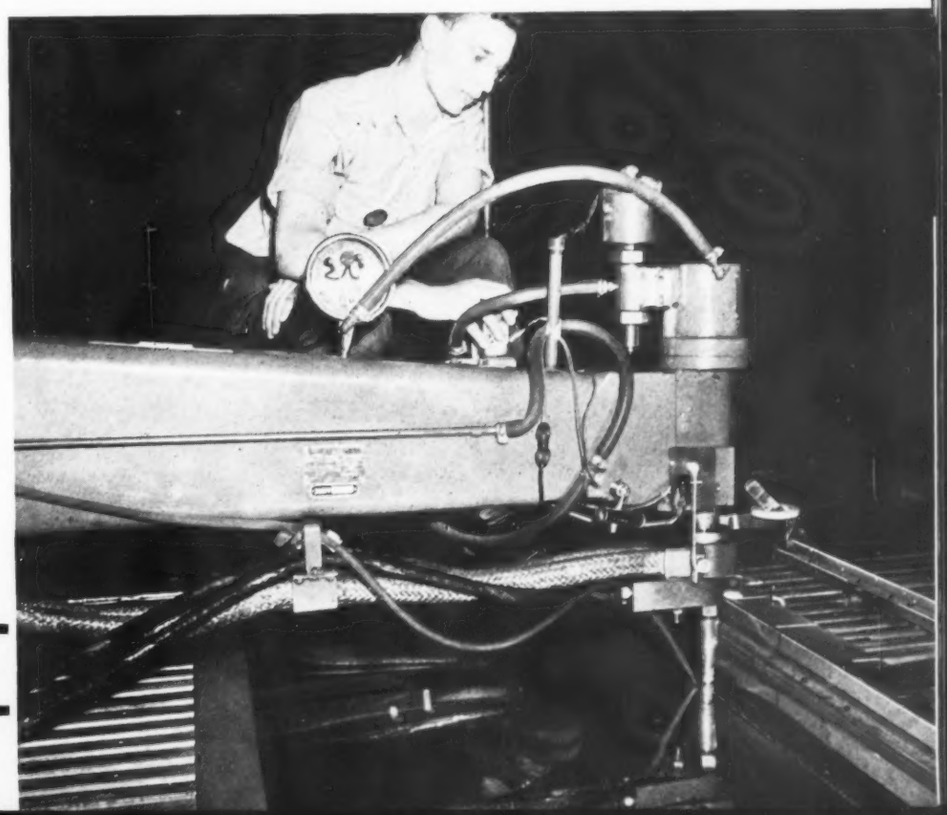

Fig. 9. One of the Spot-welding Machines Used in "Sewing" Skin Sheets together to Obtain Required Widths

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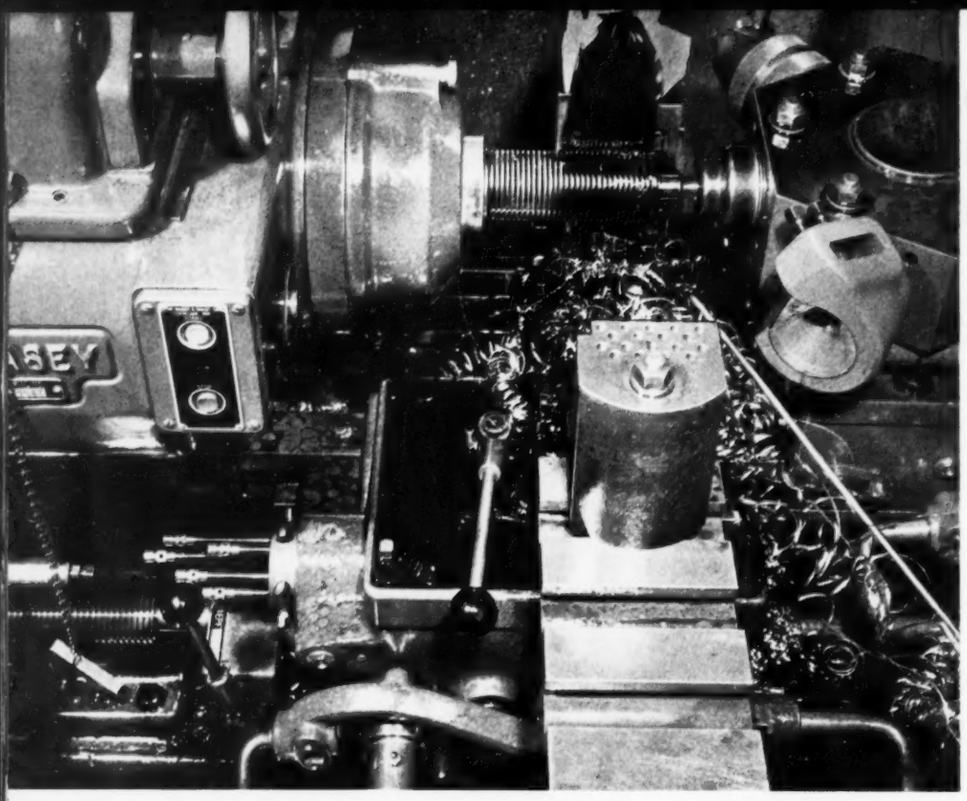

Fig. 10. Grooving Operation on a Turret Lathe, in which Roughing Tools are Mounted on the Front of the Cross-slide and Finishing Tools on the Rear

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inches. However, the bottoms of the six grooves at the head end are cut to varying depths, so as to have a core of tapered cross-section interrupted by rings of metal. Six of the cutters at the left in both the roughing and finishing groups must, therefore, be set to suit these varying depths of cut in the finished product, only nine of the cutters taking a cut to the full depth of the deepest grooves. This makes it necessary to feed the cutters into the work three times to obtain the thirty grooves. The part is produced from bars of stainless steel 12 inches long.

Three broaching operations are performed by the Lapointe horizontal hydraulic broaching machine shown in Fig. 11, to finish the jaws of forgings such as seen at the right on the faceplate of the machine to the shape shown in the part at the left. In the last operation, which is the one illustrated, the broach machines the inside of the jaw to the angular shape shown on the finished part. The first broach forms the radius on the lips of the jaw. The second broach, in three passes, machines to the bottom of the jaw to form the two corner radii on the lower ends.

Additional methods and equipment used in the Boeing machine shop will be described in a subsequent number of MACHINERY.

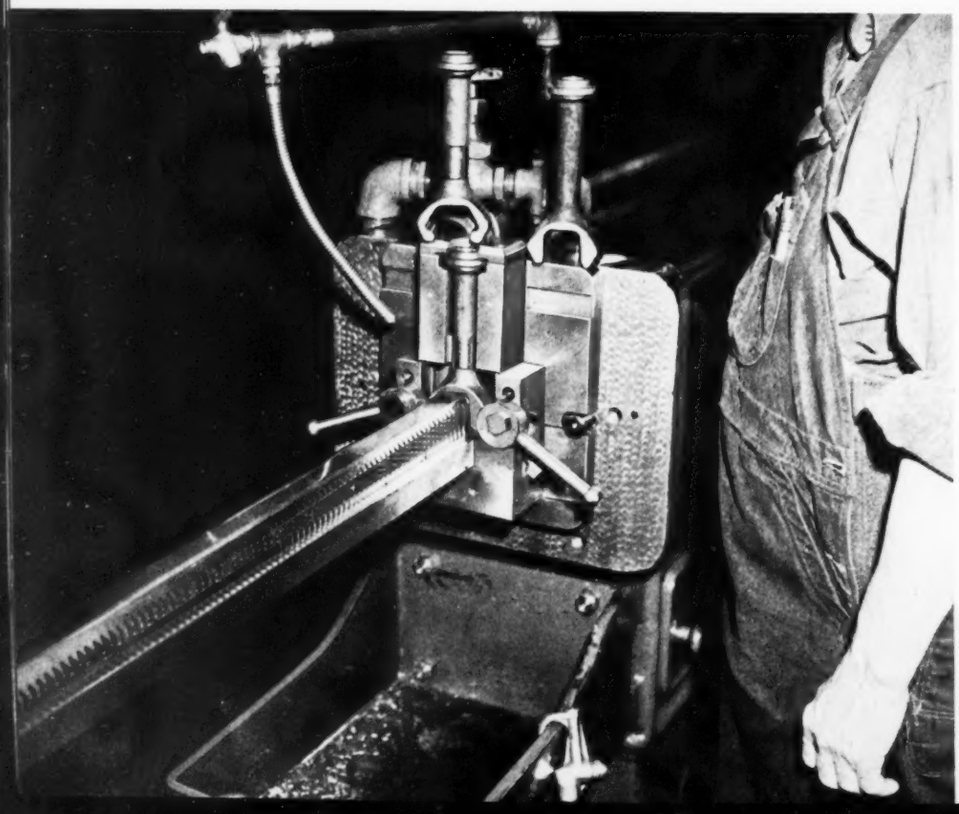

Fig. 11. One of Three Broaching Operations Performed to Machine the Jaws of Rough Forgings Such as Seen at the Right on Top of the Machine, to the Shape Seen at the Left

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Consolidated Specializes on Heavy Bombers

By HERBERT EZARD

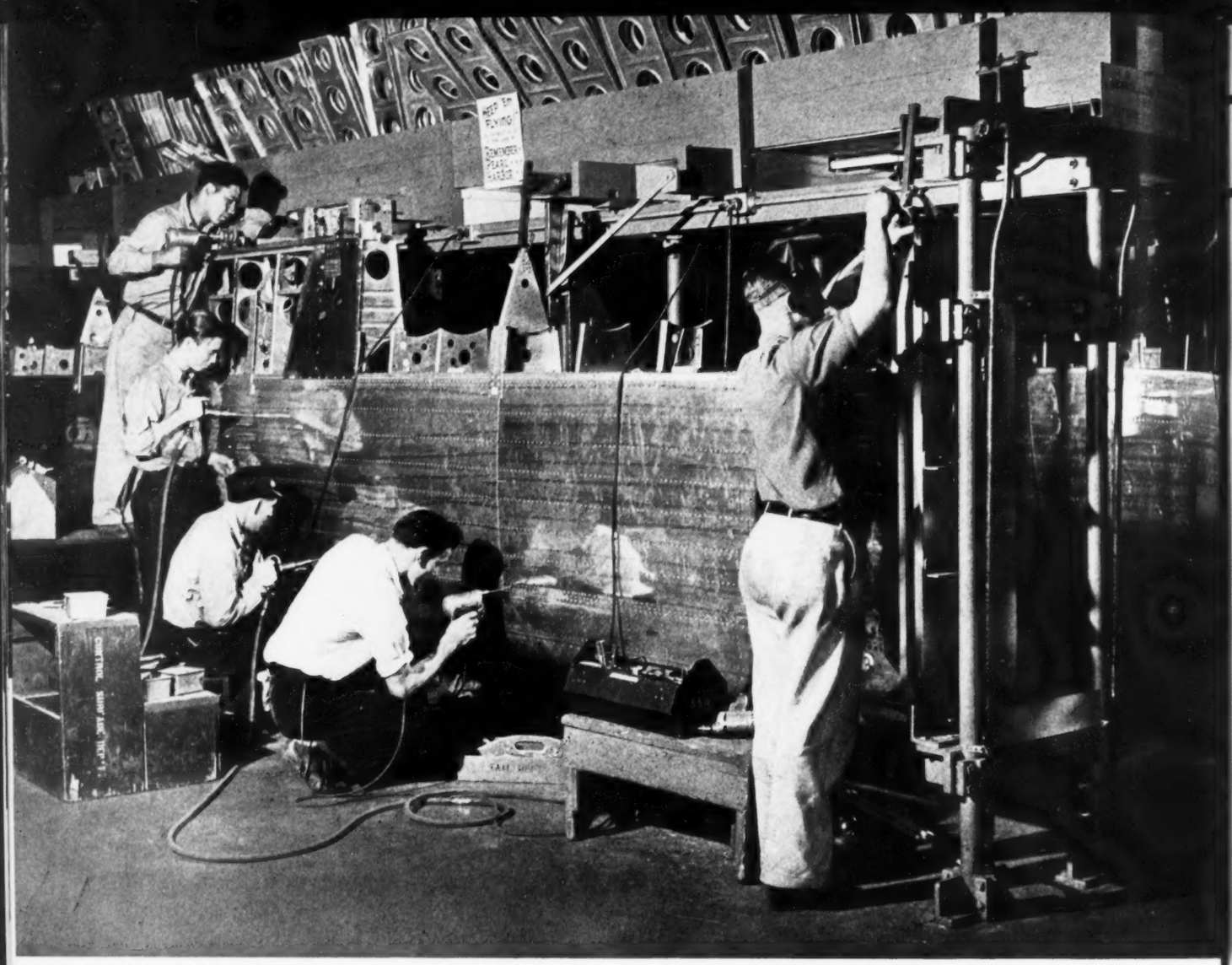

Fig. 1. All Sub-assembly Jigs have been Designed to Hold the Parts Vertically, so that the Riveters can Work with Maximum Convenience in Riveting Either Side

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Consolidated Specializes on Heavy Bombers

The Heaviest Bombing Planes of the United States Army and Big Flying Ships of the United States Navy are Now Being Turned out for Our Own Forces and for the United Nations by Mass Production Methods in a Huge Plant where Concrete was being Poured One Year Ago

By HERBERT EZARD
Factory Manager, Plant Two, Consolidated Aircraft Corporation

THE vital importance of big bombing planes to ultimate victory has become more and more evident as the war progresses. Only planes capable of carrying heavy loads of bombs comparatively long distances can effectively destroy the manufacturing plants and shipyards of our enemies that are turning out the implements of warfare or attack troops on distant battlefields and fleets at sea. The lack of a sufficient number of heavy bombing planes has heretofore been one of the handicaps of the United Nations. This has been overcome by devoting a large percentage of our airplane manufacturing capacity to the production of the bombing type of airplane.

All the facilities of the Consolidated Aircraft Corporation are being utilized in turning out planes of this classification. No plane is being built by this concern that has a wing span of less than 104 feet, and no plane weighs less than 15 tons. The concern is concentrating on the mass production of the B-24 four-engine bomber, which has a range of over 3000 miles, a speed of more than 300 miles an hour, and a capacity for carrying a bombing load of 4 tons; and also on the PB 2Y3 flying boat, which has a range of more than 5000 miles and a weight of 30 tons.

These large bombing planes are being assembled by the Consolidated Aircraft Corporation on mechanized lines, this assembling method having been adopted in spite of widespread opinion in the aircraft industry that power-driven assembly conveyors would not prove feasible in putting together airplanes weighing 30 tons or more. These power-driven assembly lines have proved so successful in stepping up production that they are sure to be adopted universally throughout the aircraft industry.

All jigs used in riveting sub-assemblies have been constructed from the viewpoint of con-

Fig. 2. View of a Wing-flap Jig, which is of Typical Vertical Construction. The Skin is Riveted on in Sections, so that the Riveter and His Helper Have an Unobstructed View as Each Rivet is Driven

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Fig. 3. Producing Hat Sections from Alclad Stock 6 Inches Wide on a Roll Forming Machine with Nine Sets of Rolls

venience. Many sections, such as wings, stabilizers, and leading edges, were formerly subassembled in horizontal positions, which made it necessary for the riveters and their helpers to perform much of their work from underneath while lying in awkward positions. Practically all such sections are now put together in vertical jigs, which enables men to work on both sides of the jig without interfering with each other. This will be apparent from Fig. 1, which shows one of the sub-assembly jigs employed in the fabrication of wing stabilizers.

The spar, leading edge, etc., are now subassembled in separate jigs and brought to this jig for assembling to the stabilizer, whereas in the past, all of these different sections were assembled in one jig. The simplicity of the new practice has speeded up production materially. An additional advantage of vertical jigs is that the floor surrounding the jigs is kept cleaner.

A view of a wing-flap jig is shown in Fig. 2. The present practice is to assemble the skin in long sheets of comparatively narrow width instead of using sheets extending the full length of the wing flap, as in former practice. With the new method, it is possible for a man on the opposite side of the work from the riveter to have an unobstructed view while "bucking up" the rivet.

Fast production of the many rolled strips, such as hat sections, required in aircraft fabrication is accomplished through the use of Yoder roll forming machines. In the typical operation illustrated in Fig. 3, a hat section is being produced from Alclad stock, 6 inches wide by 0.091 inch thick, at a speed of 120 feet per minute. Nine sets of rolls are used, the top rolls being 8 inches in nominal diameter and the bottom rolls 5 inches in diameter. The machine is

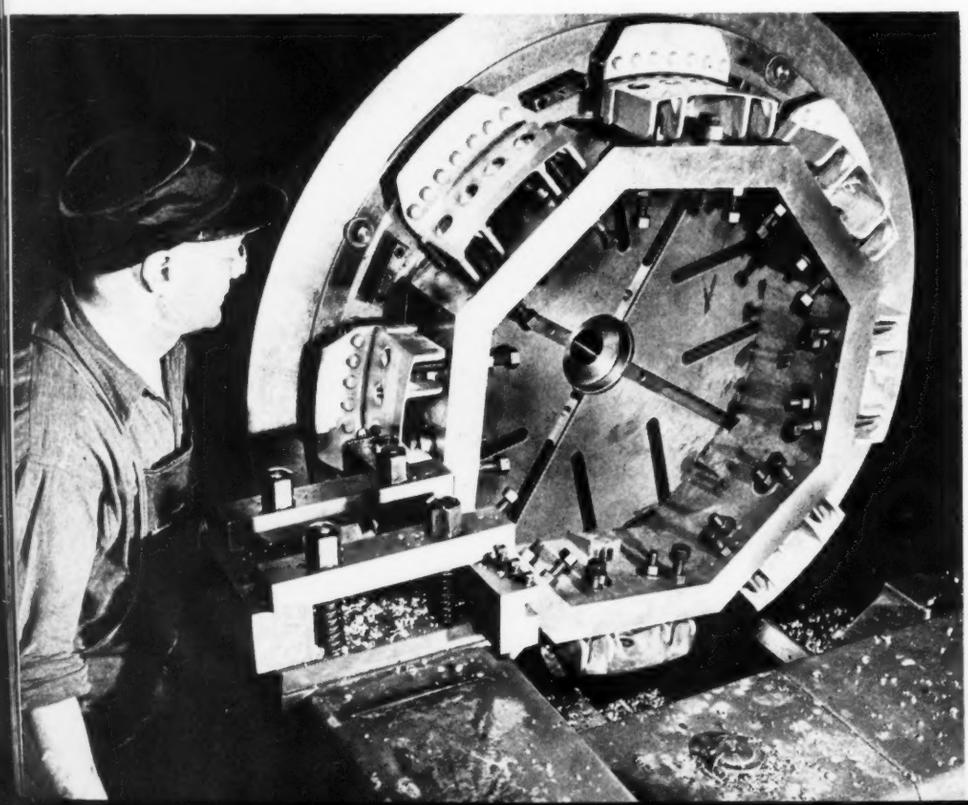

Fig. 4. Turning Eight Gun-mount Castings at a Time, with the Work Mounted on a Hexagon Fixture Attached to the Faceplate of a Large Engine Lathe

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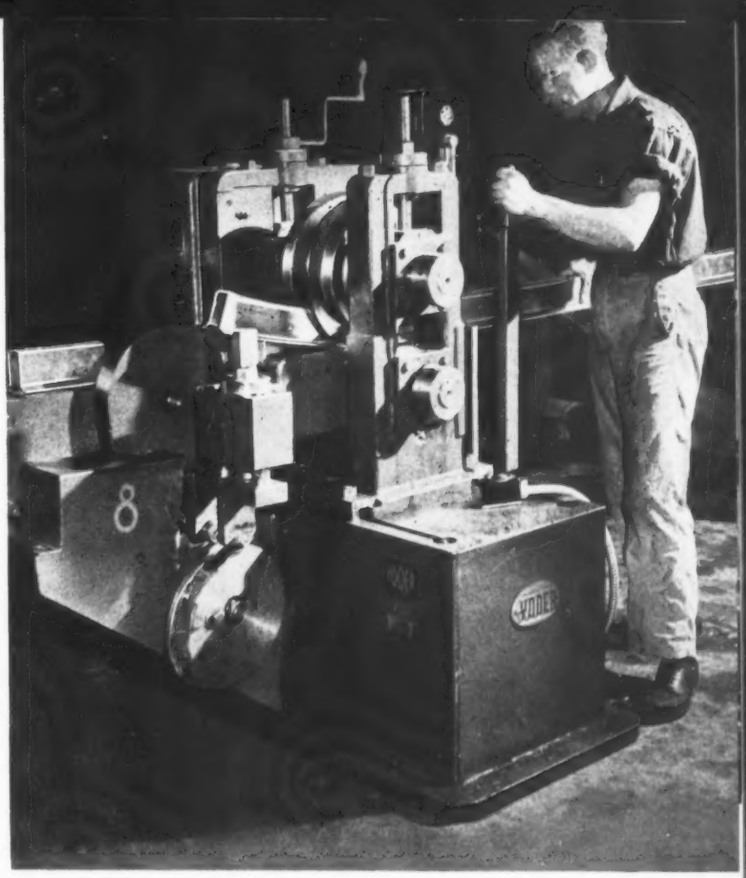

Fig. 5. Bending the End of a Hat Section to the Required Radius in a Rolling Machine of Standard Design

used for handling stock as wide as 8 3/4 inches, and as narrow as 15/16 inch.

At the point where the rolled stock leaves the machine it passes through a straightening die of the same shape as a cross-section through the hat section. The strip then passes through a shearing machine, following a long table attached to that machine until it strikes a stop which actuates the shear blade. Rolled strip can be cut off in any required lengths by setting the stop accordingly.

For some operations on the roll forming machines, universal flanging rolls are used, the flanges of which can be adjusted sideways to vary the width between them. Adjustments are made by merely applying a spanner wrench to collars on the rollers for screwing the rolls along threads on the shafts on which they are mounted.

In Fig. 5 is shown another Yoder machine, which is used for bending rolled sections to specified radii by feeding them between two rolls shaped to suit the sections. This machine is employed for bending to radii as small as 1/2 inch and as large as 4 5/8 inches.

The remaining operations described in this article are principally in the machine shop, which has been tooled up completely for quantity production. In Fig. 4 is shown a LeBlond engine lathe of 60 inches swing engaged in machining cast aluminum-alloy mounts for machine guns, eight at a time. The correct relationship between the finish-turned surface and the small finished bosses seen on the surface at right angles to that being finished must be maintained within plus or minus 5 minutes, or 1/12 of a degree. The Carboloy-tipped turning tool used gives an exceptionally fine finish.

In Fig. 6 a beaching-gear housing for a fly-

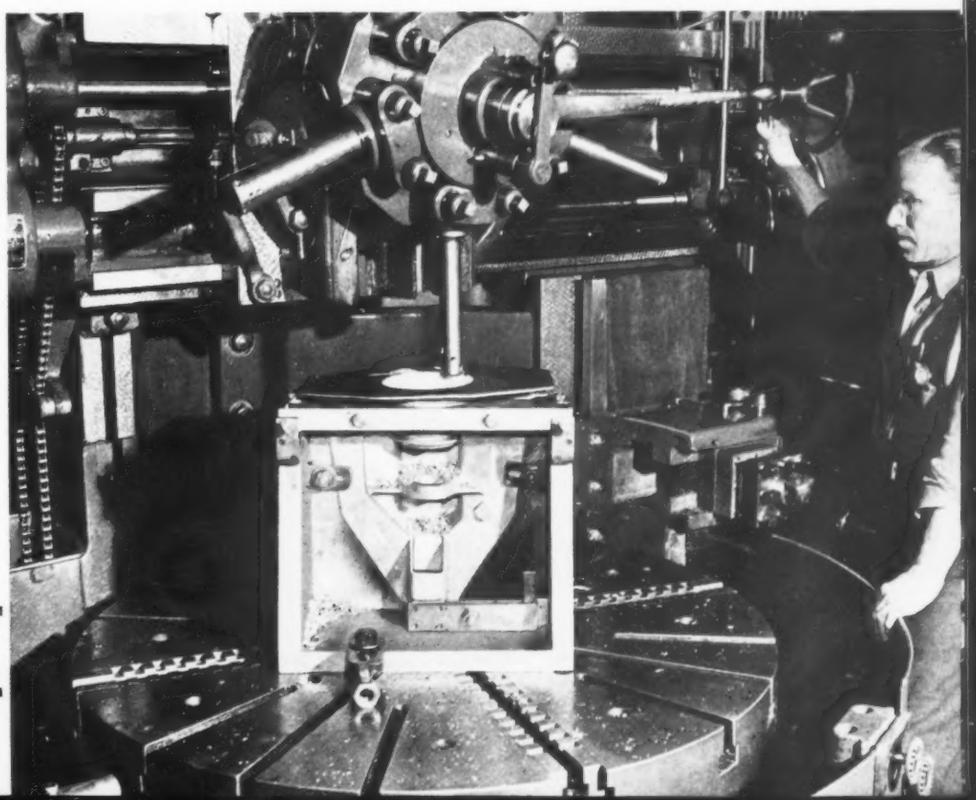

Fig. 6. Boring a Beaching-gear Housing to Four Diameters, Chamfering the Top Bore, and Facing the Flange at the Upper End on a Vertical Turret Lathe

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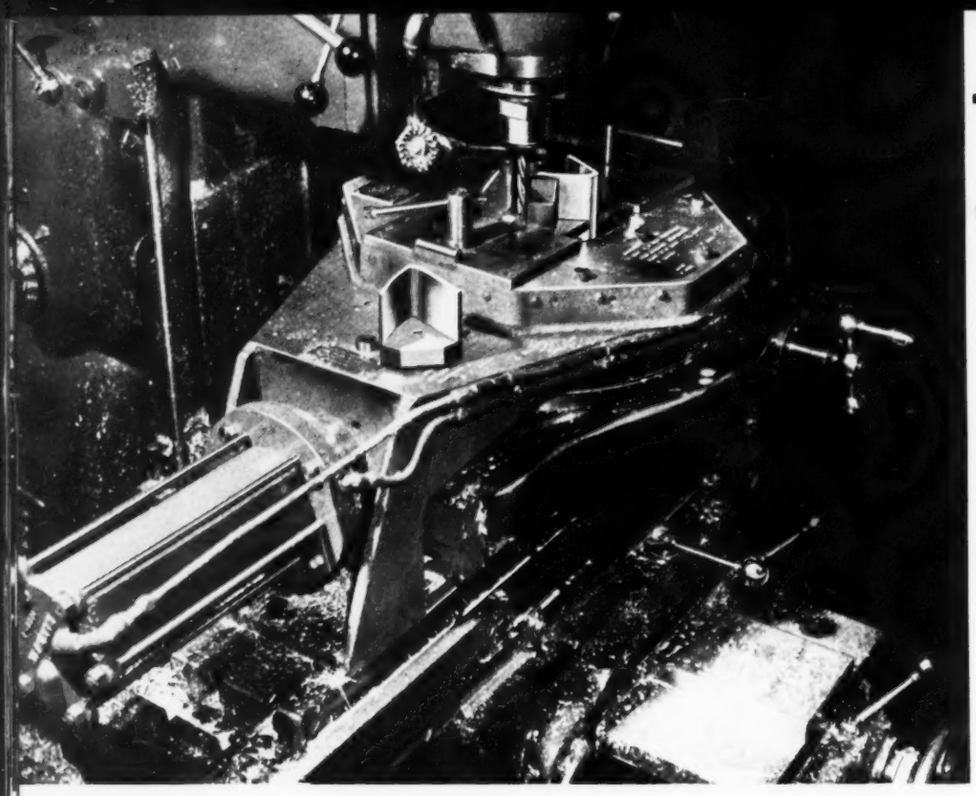

Fig. 7. Ingenious Work Fixture Designed for the Automatic Contour-milling of Corners for Oil Tanks

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ing ship is being machined on a Bullard vertical turret lathe. This part is an aluminum sand casting. The operation consists of boring to four diameters, chamfering the top bore, and facing the wide flange at the top of the casting. The tolerance on three of the bores is plus nothing, minus 0.001 inch, but it is somewhat greater on the fourth bore. The diameters range from 2.750 to 6.475 inches. Heights are held to a tolerance of plus nothing, minus 0.010 inch. The part is located from a previously milled face, which is clamped against one side of the box jig.

A work fixture of ingenious design was provided on the Milwaukee vertical-spindle milling machine shown in Fig. 7 for milling oil-tank corners. One side of these aluminum 24 ST forgings is flat on both the inner and outer surfaces, but the opposite side is curved to a radius of about 60 inches on the inner surface and blended with a 9/16-inch radius at the front end. The outer surface is correspondingly curved. Two parts are milled in each set-up.

Slidably mounted on the horizontal table of this machine is a rotary table which is provided with a large cam that revolves during an operation. This cam is kept in contact with a roller by pressure exerted on the rotary table through the pneumatic cylinder seen mounted on the

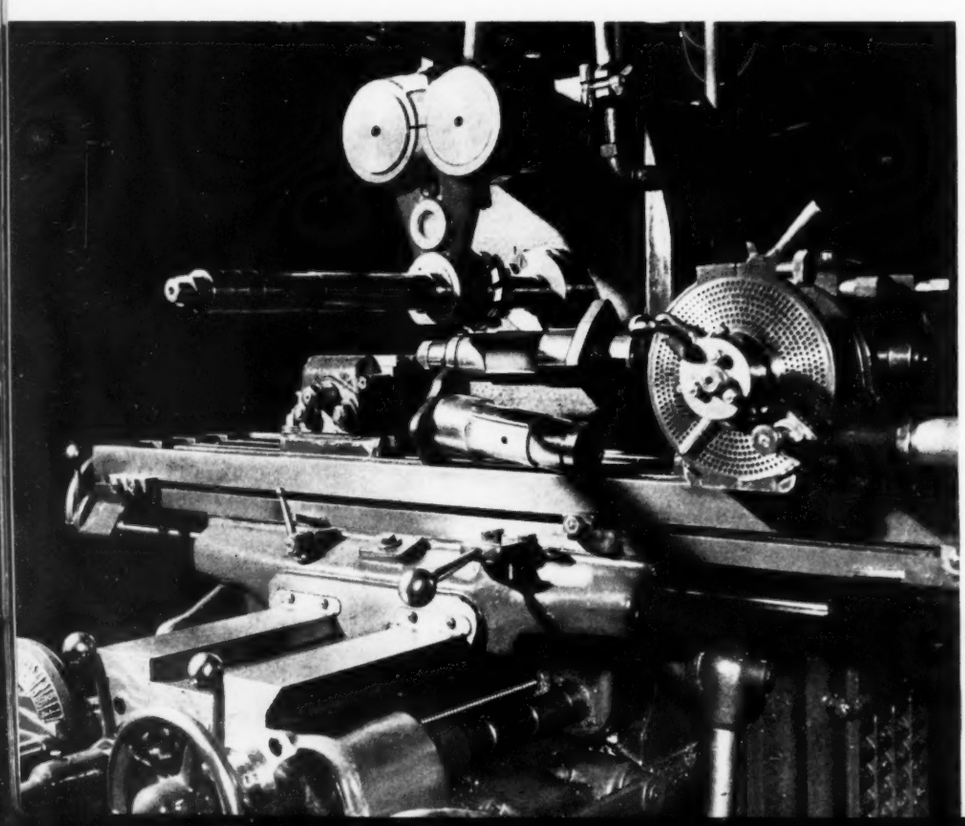

Fig. 8. Form-milling Operation which Leaves Two Integral Keys on Opposite Sides of a Stainless-steel Forging

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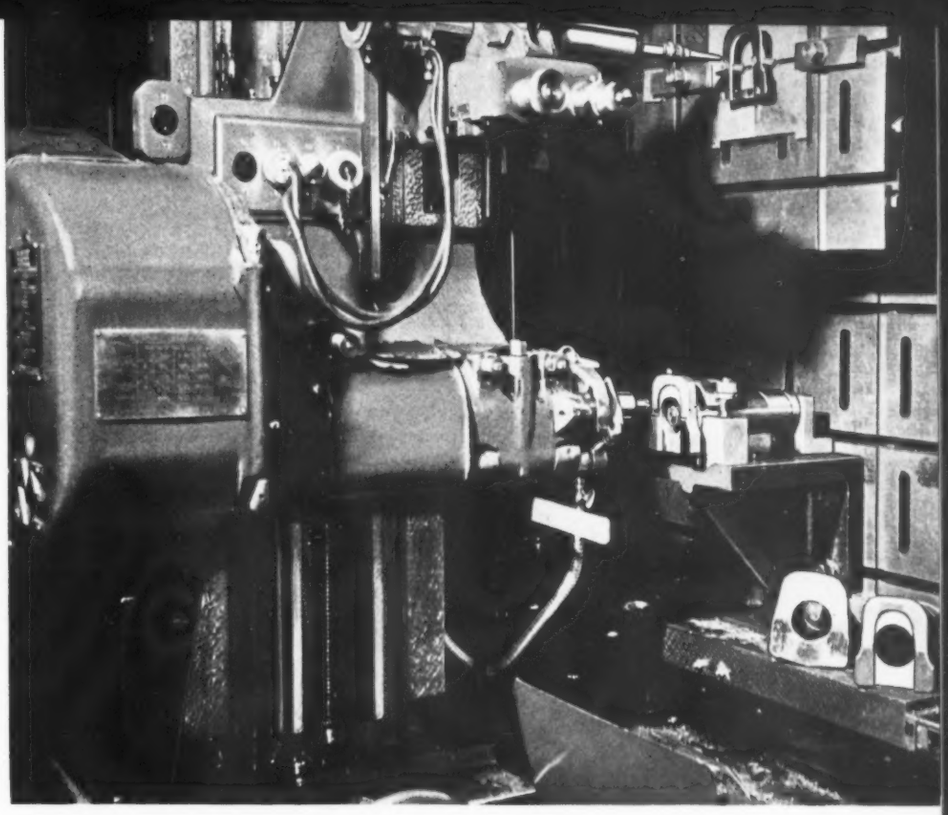

Fig. 9. Profile-milling One End of Stainless-steel Forgings to Two Outlines on a Kellermatic Machine

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left-hand end of the work fixture. As the fixture is clamped to the horizontal table, and the latter is locked, so that it remains stationary, the effect of the cam rotation is to cause longitudinal movements of the rotary table on the horizontal table. A sliding member on top of the work fixture is so connected to the rotary table that the longitudinal movements imparted to this table are transmitted to the top slide. The required in-and-out movements of the work are obtained through the regular mechanical cross-feed of the saddle on the milling machine.

In setting up for an operation, two slides on the work fixture are moved against the side of the castings to locate them accurately in the center of the fixture. When the outer surfaces are to be milled, the clamps contact with the inside, and conversely, when the internal surfaces are to be milled, the clamps contact with the outer surfaces, as shown in the illustration. Stock from 1/16 to 1/8 inch deep is removed, the cut on the outer surfaces being 3 1/2 inches wide, and on the inner surfaces 2 1/2 inches wide. An end-mill of left-hand spiral is used, cutters of right-hand spiral having proved unsatisfactory for this operation.

A Milwaukee horizontal-spindle milling machine is shown in Fig. 8 set up for form-milling

Fig. 10. Straddle-milling One End of Strut Attachment Fittings to a Close Tolerance with Carboloy-tipped Cutters

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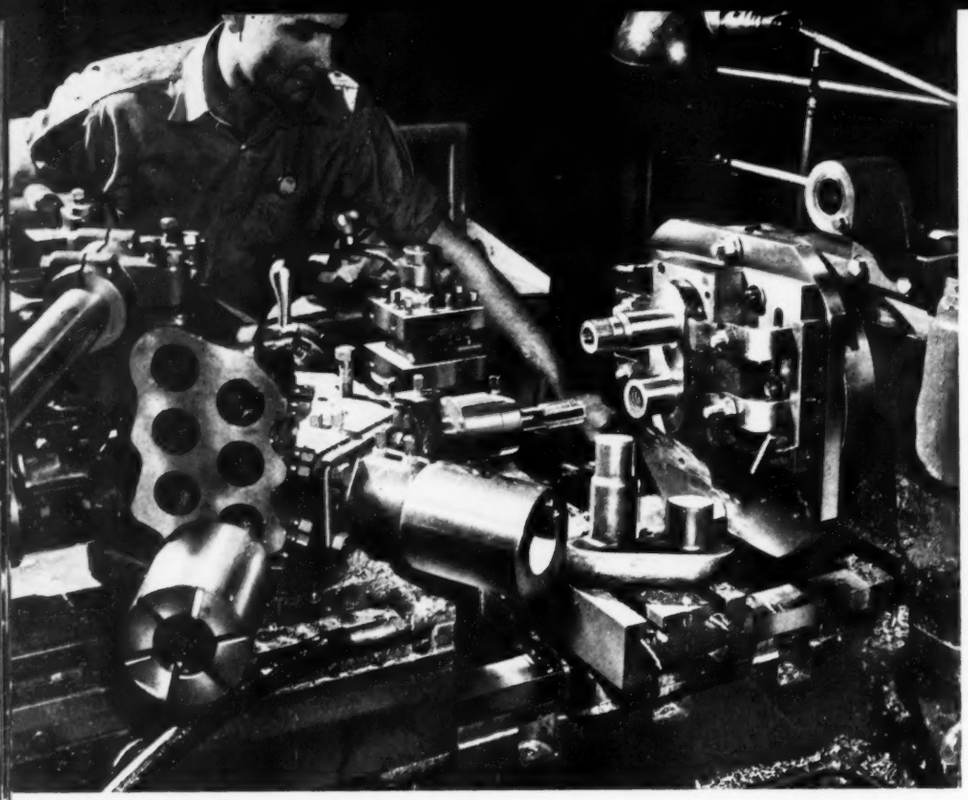

Fig. 11. Turret Lathe Equipped with an Indexing Fixture that Permits the Two Posts of External Fittings for Hull Chines to be Machined in One Set-up

the shank of landing-gear locking pinions to a reduced diameter. The surface is milled completely around the part, except for a width of about 3/4 inch on each side, thus leaving integral keys, as indicated by the example lying at the front of the table. The widths of the keys must be held to size within plus nothing, minus 0.005 inch, and the keys must be on center within 0.002 inch. The diameter is held to size within plus nothing, minus 0.003 inch. The dividing head provides a means of turning the work in increments between successive feed movements of the horizontal table. The workpiece is a forging of stainless steel.

One end of this part is milled to a horseshoe shape by a Kellermatic machine set up as illustrated in Fig. 9, and a depression is milled in the face of the same end to a somewhat similar outline. In both steps of the operation, the tool is automatically guided in the required path as an electrical tracer follows either the inside or outside contours of a steel templet plate, mounted on the vertical table above the work. The depth of cut taken around the outside of the piece varies from 1/16 to 1/2 inch.

One end of strut attachment fittings is straddle-milled to a thickness of 0.500 inch within plus or minus 0.001 inch in the operation illus-

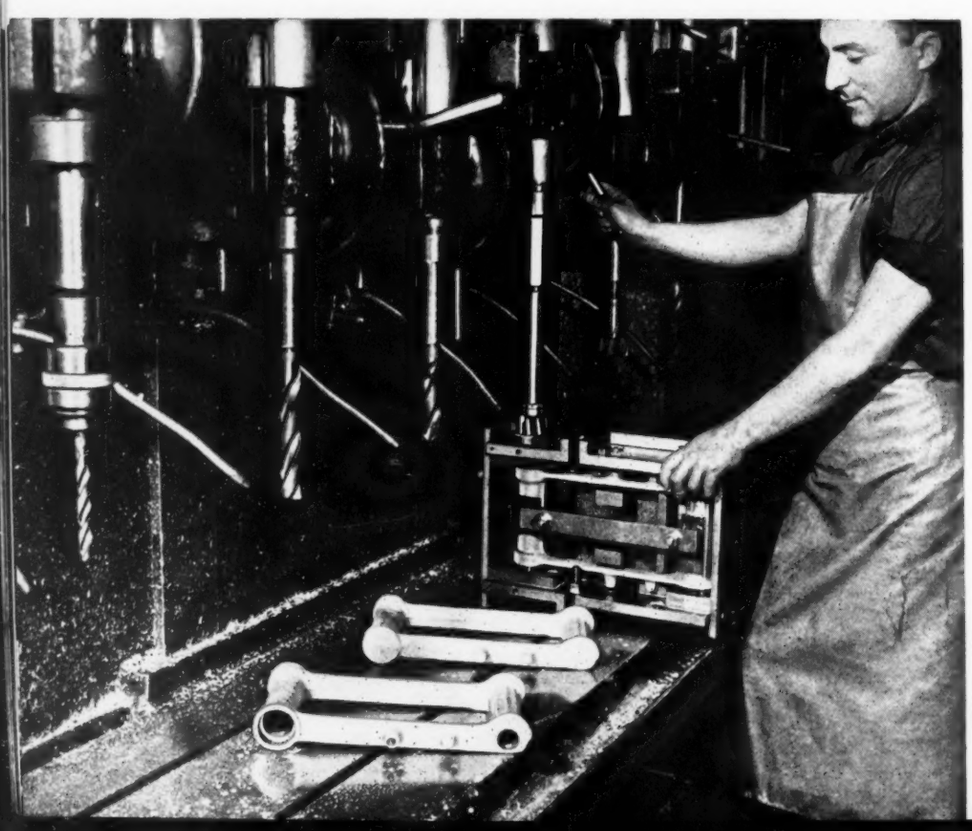

Fig. 12. Gang Drilling Machines are Widely Used for the Performance of a Multiple Number of Operations on Various Aircraft Parts

Fig. 13. Electric Arc Welding is Used Extensively for Work Ranging in Size from the Large Bomb Rack Seen in the Jig to the Small Piece at the Front of the Jig

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trated in Fig. 10, which is performed on a Cincinnati horizontal-spindle milling machine. Roughing and finishing cuts are taken, the depth of the roughing cut being about 1/8 inch, and that of the finishing cut about 0.002 inch. The cuts are taken by Carboloy-tipped blades mounted on steel disks approximately 10 inches in diameter, which are rotated fast enough to give a surface cutting speed of about 4000 feet a minute. The work is an aluminum-alloy forging. The fixture is made especially heavy to insure solid holding of the work, which is of such length that it must extend down past the top of the table on the inner side.

Fig. 11 shows a Jones & Lamson turret lathe engaged in machining external fittings for hull chines. The parts come to this machine in the form of rough stainless-steel forgings, as seen by the example lying on the back of the cross-slide, and leave the turret lathe with the two posts finished, as shown by the part on the headstock fixture. This fixture is of a special design which permits the part to be indexed for finishing the two posts in one set-up of the work. The posts are held to the specified center distances within plus 0.005 inch, minus nothing, and the diameters are held to a tolerance of plus 0.003 inch, minus nothing.

Fig. 14. Forging Machines Turn out the Millions of Aluminum and Stainless-steel Rivets Required in the Manufacture of Airplanes

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Either the long or the short post can be machined first. The first step in machining the short post consists of using a hollow-mill on the hexagon turret to machine the external diameter. Then a second hollow-mill on the hexagon turret is advanced to face the cheek of the forging adjacent to the post. Next, a third hollow-mill on the turret takes a finishing cut on the outside diameter of the post, after which a tool on the square turret at the front of the cross-slide is fed sidewise to face the end of the post. The next step consists of using a tool on the hexagon turret to produce the hole in the post, and finally this hole is threaded by a tap on the hexagon turret.

In machining the long post, the first step consists of rough hollow-milling the small diameter on the long shank with a tool on the hexagon turret, after which the large diameter is rough hollow-milled, the small diameter is finish hollow-milled, and the large diameter is finish hollow-milled, all with tools mounted on the hexagon turret. The hollow-mill that finishes the large diameter also takes a facing cut on the cheek of the forging. The next step in the operation consists of under-cutting for the external thread, and cutting the taper between the two diameters, this being done by a tool on the square turret. Then the thread is cut on the outer end of the post by a collapsible die-head on the hexagon turret. The seventh step in the operation consists of drilling the post, and the eighth step of reaming the drilled hole, both of these steps being performed with tools on the hexagon turret.

In Fig. 12 an Avey six-spindle gang type drilling machine is being used for performing a multiple number of operations on a rudder pedal. The aluminum-alloy forging is securely clamped in a box jig, as shown, for drilling, reaming, and counterboring the large hole that extends through one end of the piece, as shown by the front example on the table; and also for drilling the smaller hole through the opposite end, and drilling and reaming still smaller holes through lugs and bosses on the ribs. The large hole is reamed to 1 5/8 inches in diameter and counterbored to 2 inches within a close dimensional tolerance.

Electric arc welding has been substituted for practically all the oxy-acetylene welding operations of previous days. The wide range of work handled by this process is indicated in Fig. 13 by the bomb rack seen in the jig, and the small piece of work lying on the angle-iron at the front of the jig. The jig is of an indexing design, so that all welds can be made in positions convenient to the welder. Chromium-molybdenum steel tubing milled to the required shapes at the ends is being welded to feet cut from steel plate of the same analysis.

The millions of rivets required in manufacturing Consolidated airplanes are produced right in the plant by National forging machines. Fig. 14 shows one of these machines producing aluminum-alloy rivets 3/8 inch in diameter by about 3 1/2 inches long, with a head 3/4 inch in diameter. These rivets, the largest made in the plant, are produced at the rate of several hundred a minute. Small rivets are turned out at twice the speed. The rivets are made of stainless steel and of 17S and A17S aluminum.

All the articles in this special Aircraft Production Section have been approved for publication by the U. S. War Department.

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Drills for Hardened Steel Solve an Aircraft Production Problem

Former Practice Required the Drilling of Certain Aircraft Engine Parts before Casehardening. In Some of These Parts Distortion Often Resulted, while Expensive Grinding Operations were Required for Others. With the Special Drills Now Available, Full Casehardening of These Parts is Possible before Drilling

By F. G. GEPFERT, Vice-President and Chief Engineer, Black Drill Co.

Approved for Publication by the War Department

DURING the past year many applications have been developed for a new type of drill which can be used for drilling materials having hardnesses beyond the capacity of the ordinary high-speed steel twist drill. These materials include carburized, oil-hardened, water-hardened, cyanided and nitrided steels having a hardness of 40 Rockwell C or higher. In many cases, costly machining operations formerly necessary in conjunction with the drilling have been eliminated.

These drills, known as "Hardsteel," differ from conventional twist drills in both shape and material. The drill body is straight, with a triangular cross-section to provide ample chip clearance. The point angle is normally 65 degrees. For counterboring and flat-bottoming work, the point is ground flat. Cutting takes place only on the bearing surface.

One of the most noteworthy applications of these drills is in the aircraft engine field. For example, in one department of the Buick plant oil-holes are drilled through the connecting-rod bearing surfaces of crankshafts for the Pratt & Whitney duplex engine. In the original lay-out, the holes were spot-drilled with twist drills after carburizing, but before casehardening. However, it was found that the casehardened parts, particularly the throws and the adjacent sections of the crankshaft, became distorted during the hardening operation. This distortion was great enough in some cases to change the original circular shape of the spot-drilled impressions to a definite ellipse. In too many instances, it was found that this distortion rendered the shaft unfit for final finishing.

Analysis of the possible reasons for this distortion led to the conclusion that the cause lay in the breaking of the surface of the casehardened metal at the spot-drilled points around the shaft. This indicated the need for a complete

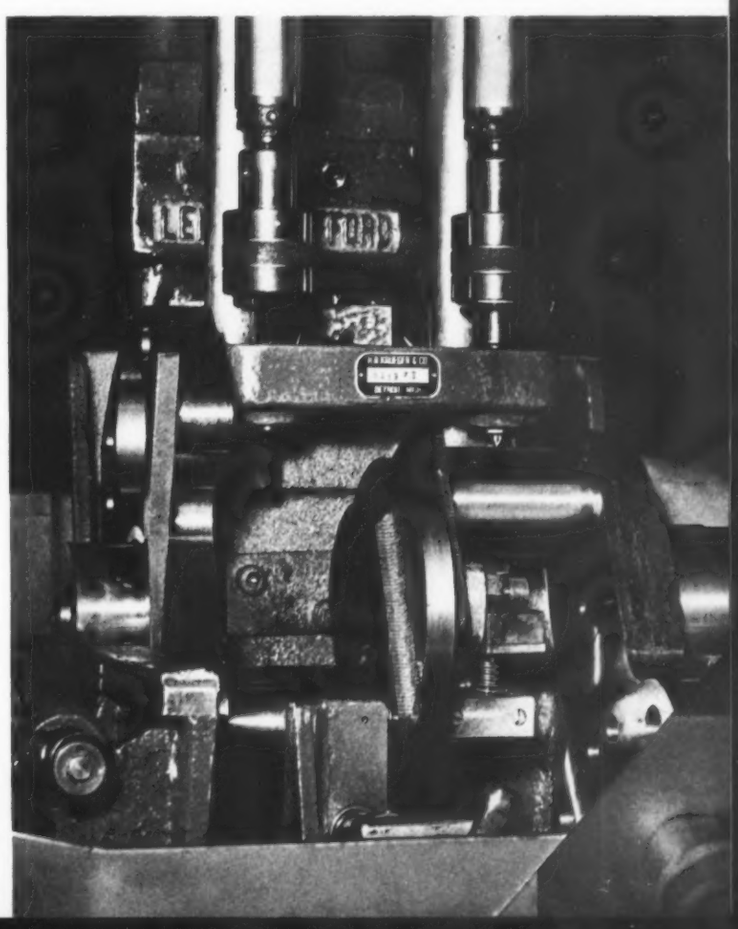


Fig. 1. Using a "Hardsteel" Drill for Spot-drilling Oil-holes in the Hardened Steel Crankpins of a Pratt & Whitney Twin-engine Crankshaft at the Buick Plant, with the Throws in a Vertical Position

revision of the drilling procedure, which had been based on former automotive manufacturing practice. So, typical of the broad thinking that has characterized the automotive industry in its change-over to aviation production, Buick threw precedent into the discard, and made a radical change in order to take advantage of a new practice made possible by the "Hardsteel" drill, a tool unknown to industry until about a year ago.

According to the new practice, these medium-carbon, high-alloy crankshafts are carburized and completely hardened before being spot-drilled. The shaft is then taken to a drill press and placed in a specially designed fixture that holds it with the throws in a vertical plane, as shown in Fig. 1. A special 3/8-inch "Hardsteel" drill, with the point ground to a 60-degree included angle, is fed into the work through a guide bushing. The drill revolves at 1800 R.P.M., and a hand feed is used. Penetration of the hardened surface is easily accomplished, and drilling continues until the diameter of the spot is about 5/16 inch.

Two such spot-drillings are made in line in each of the bearing surfaces; the shaft is then inverted, and an equal number of spot-drillings is made diametrically opposite. The shaft is then realigned in a fixture in another drill press with the throws in a horizontal plane, as shown in Fig. 2. In this operation, a single hole is drilled in the center of each bearing surface at a point 90 degrees around the circumference from the other holes.

Next, a single-spindle drill press, with suitable jigs, is used to bring the diameter of the finished spot to an exact specified size, which is checked by gaging as illustrated in Fig. 3.

After the hardened bearing surface has been penetrated by a "Hardsteel" drill, a high-speed steel twist drill is used to complete the hole through the soft core to the hollow center. This operation is performed in the same drill press, and the set-up is the same, except that a proper size of bushing is substituted.

Since the change to the new procedure several months ago, there have been no crankshaft rejections chargeable to off-position spot-drilling. These parts are moving faster into much-needed aircraft engines, and the man-hours formerly spent on prior operations are being saved. Costs, too, have been lowered. While no definite figures are available, it is estimated that with the new type drills forty to fifty spot-drillings are made per grind, with about twenty grinds per drill, indicating an extremely low cost per drilling.

Another example of how the use of these drills has eliminated some of the troubles caused by hardening distortion is the case of an aircraft engine manufacturer, the Muskegon Motor Specialties Division of Houdaille-Hershey Corporation. Under the original plan, Rolls-Royce camshafts of S A E 4620 steel were drilled and reamed prior to hardening. Owing to the displacement of the metal masses in the cams and bearings, external distortion caused by hardening necessitated a difficult and time-consuming straightening operation. Also, external distortion resulted in a bore that was not as true as desired.

Here, the use of drills for hardened steel permitted finishing, except for the final grinds, and full hardening of the piece to 60 Rockwell C before drilling, with the elimination of many rejections.

In this application, a 43/64-inch "Hardsteel" drill is chucked and mounted on the turret of

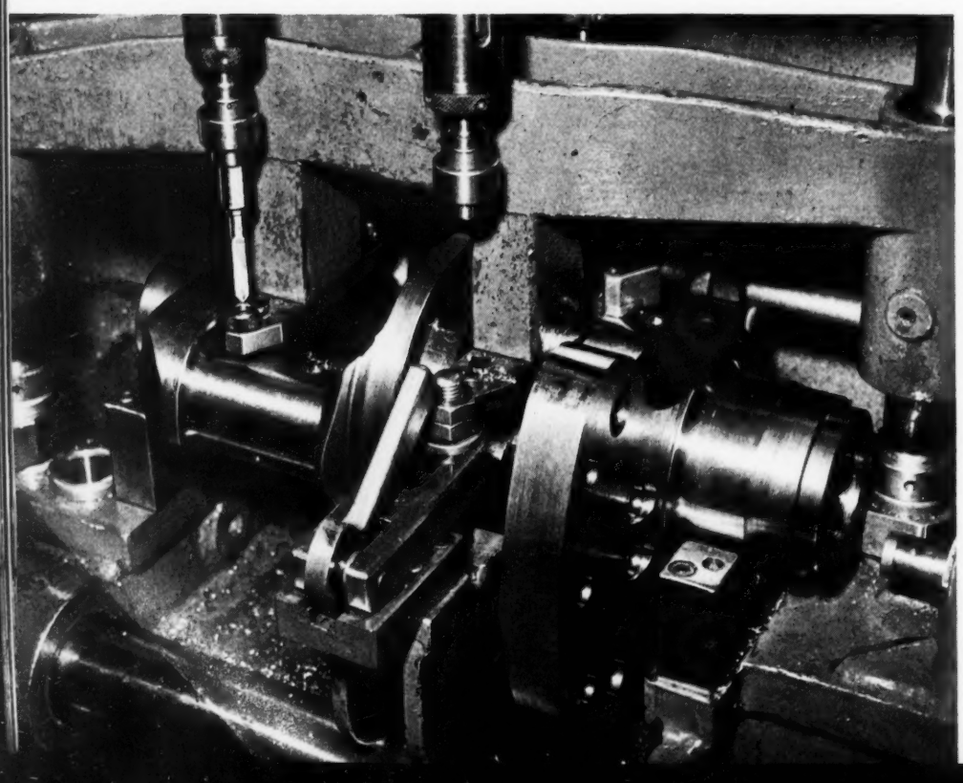


Fig. 2. An Operation Similar to that Shown in Fig. 1, being Performed with the Crankshaft Throws in a Horizontal Position

VICTORY

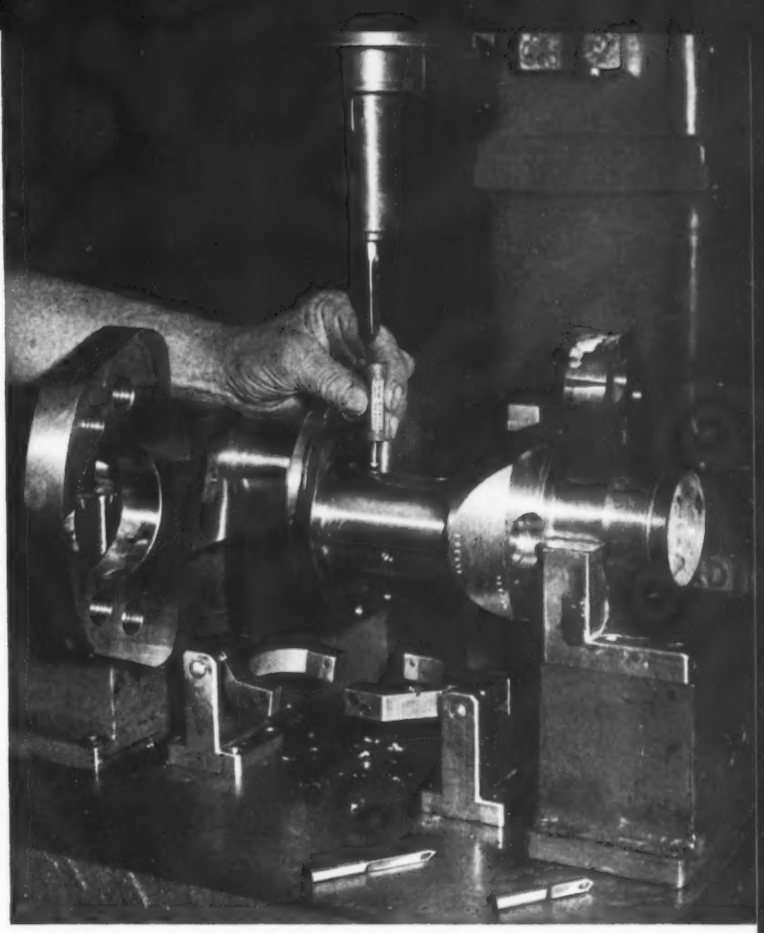


Fig. 3. Gaging the Final Diameter of the "Spot." Constant Checking Maintains Precision at All Points

a turret lathe, as shown in Fig. 5, and the camshaft rotated at 700 R.P.M. as the drill is fed to the work by hand. Penetration is from 3/16 to 1/4 inch, well through the case. Fig. 4 shows a close-up view of the drill used to make this impression.

Subsequently, the shafts are rifle-drilled and reamed to the desired diameter. In this whole operation, no guide bushings are required, as the camshafts have previously been centered for prior machining operations.

The new method has resulted in substantial improvements. The final bore is true and smooth. Over-all costs have shown a worthwhile reduction, and production has been increased considerably.

Another manufacturer making camshafts for straight-in-line V-type aircraft engines has simplified the machining method by the use of the new drills. Formerly, a plug was left on one end of the camshaft to permit chucking for the grinding operation. After the piece was hardened, the plug was ground off at considerable expense, from the standpoint of both time and money. The use of the new type drills has enabled this manufacturer to cut the shafts to exact final length; drill to within 1 inch of the far end before hardening, leaving the end solid for a center for the grinding operation; and then drill through the remainder of the shaft after hardening.

An even more expensive grinding operation was formerly necessary in an aircraft plant, where the lower end of a push-rod for a cam was being made of carburized steel. The procedure had been to harden the piece, grind the rounded end (the only portion of the work that had to be hard) and then to grind the work, a great many pieces at a time, on a Blanchard grinder, in order to remove the hardened skin from the other end. This was done so that a hole for the push-rod might be drilled in the soft steel core. It was necessary to grind off 1/16 inch of carburized steel, which was an extremely expensive and wasteful process, and

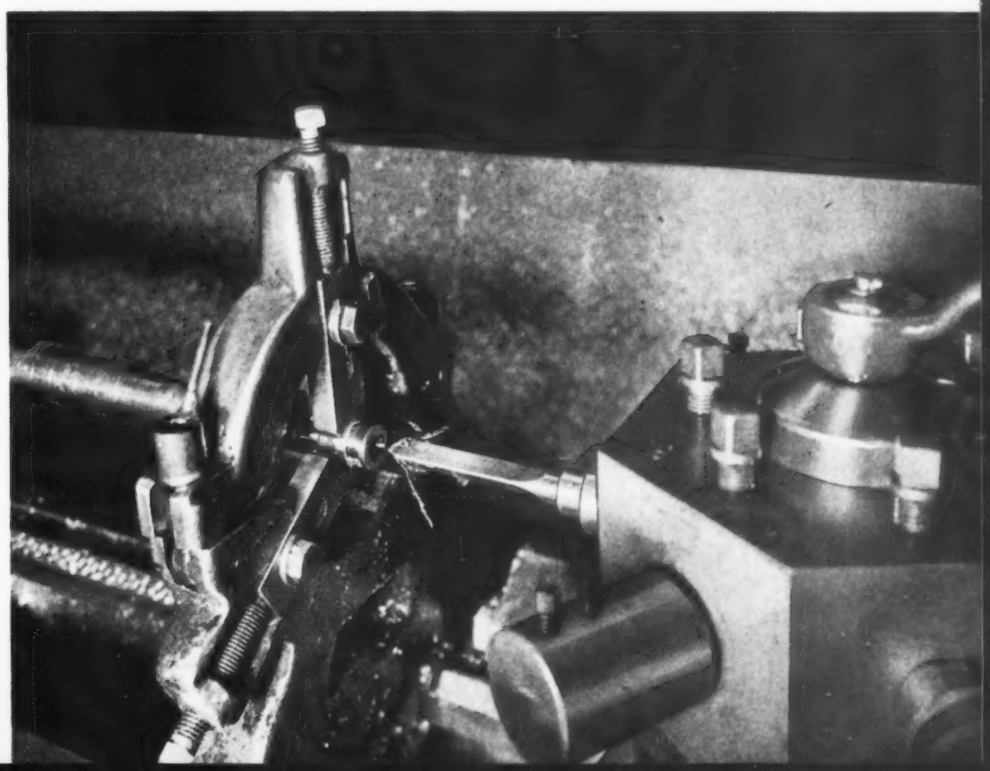


Fig. 4. Close-up View of "Hardsteel" Triangular-shaped Drill Used to Start Hole in Hardened End of Rolls-Royce Camshaft

VICTORY

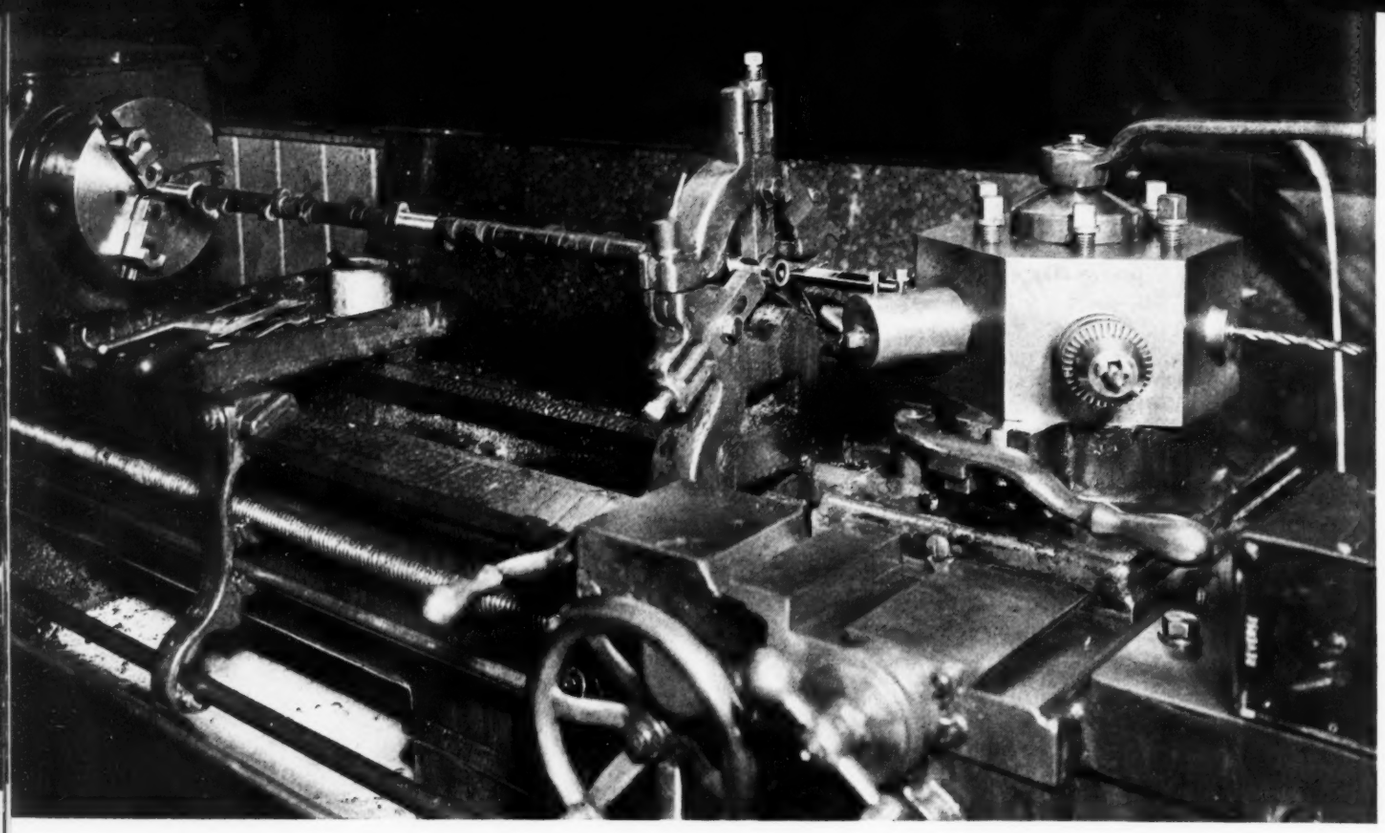


Fig. 5. Drilling the Hardened End of a Rolls-Royce Camshaft at Muskegon Motor Specialties Preliminary to Rifle-drilling. A Speed of 700 R.P.M. is Used

cost approximately $7500 a year in grinding wheels alone, to say nothing of the labor cost involved. This waste was completely eliminated by using "Hardsteel" drills, which made it possible to drill through the hardened surface in five seconds.

As a matter of interest it may be pointed out that no special equipment or unusually skilled help is required to obtain satisfactory results with these drills. It is important, however, that certain precautions be followed in the use of speeds and feeds. Most of the drilling operations can be carried on dry, but where it is imperative to retain absolute hardness at the walls, and to prevent discoloration of the work, a coolant should be employed.

Because these drills have been developed for the specific job of drilling in hardened steel, they will not work successfully in soft steel. Their application begins where the good high-speed twist drills—and there are many on the market—leave off. Consequently, when a piece of steel with a hard exterior must be drilled, it is necessary to change to an ordinary drill after the hard exterior has been penetrated by these special drills. Although "Hardsteel" drills were originally developed especially for use in the tool-room, they are rapidly finding their place as a production tool in many metal-working industries, where they are changing old time-honored customs and setting new standards of efficiency and economy.

Stahl Gear & Machine Co. Celebrates Twenty-Fifth Anniversary

IN April, 1917, the Stahl Gear & Machine Co. was started by George Stahl, who still remains the head of the firm. A small building was leased in Cleveland. The floor space was limited, the building was ill adapted to the needs of heavy industry, and the plant was not an imposing one in appearance; but in these cramped quarters was installed some of the best gear cutting, hobbing, and finishing equipment available in the country. Today, the company occupies a modern plant at 3901 Hamilton Ave., in Cleveland. This plant has approximately 40,000 square feet of floor space, is exceptionally well lighted, and is provided with ample crane facilities, so that the shop is capable of handling heavy work.

Engineering News Flashes

Cellular Rubber, Lighter than Cork, is Used for Life Rafts

An interesting use is being made of a new type of cellular rubber which has twice the buoyancy of cork. According to the United States Rubber Co., life rafts are constructed by the Sculler Safety Corporation, New York City, from a spider-like network of disks of this new material, strung together with ropes. Self-lighting electric lamps float in the water beside the raft to guide rescuers at night.

Because of the extreme lightness of this material, which is composed of millions of small cells filled with nitrogen gas, rafts can be built that can support up to thirty people. An advantage claimed for this construction is the ease with which the edges of the raft can be grasped in the water. The raft can be thrown overboard when there would be no time for launching a lifeboat or an ordinary raft.

Cellular rubber is a non-conductor of heat, and will not absorb moisture. it is resistant to oil, acid, vermin, or termites. It can be cut by band or power saws or planed like wood. An important use for this material after the war will be for wall boards in the building industry.

Low-Temperature Chilling Equipment for Industrial Use

Industrial low-temperature chilling equipment which is capable of delivering controlled temperatures down to minus 120 degrees F. is being made by the Deepfreeze Division of the Motor Products Corporation, 2301 Davis St., North Chicago, Ill. This equipment is intended for plants having production problems that demand extremely low temperatures in connection with which dry ice is now used. It is said that more than one hundred laboratories and other industrial concerns are using the new chilling equipment, both in research and production.

Unique Method for Saving Time When Installing Large Machine Tools

The General Electric Co. recently saved three months of the time previously required for putting some 96-inch hobbing machines into operation. This was accomplished by sending six shop men to the plant of the machine tool builder to study, on the job, the manufacture and assembly of the machines. In previous practice, the hobbing machines had been assembled in the machine tool builder's plant, tested, and then taken apart for shipment to the purchaser's plant where they were reassembled.

By training the six G-E men in the process of assembling and testing the machines, the preliminary assembly in the machine tool builder's plant was dispensed with, and the machines were shipped directly to the General Electric plant for assembling and testing. In addition, the men who had gained experience in the machine tool plant are now acting as instructors in the General Electric shops, passing along their training to other men.

Induction Heating Speeds Production of Machine Parts

The need for greater speed in heat-treating steel machine parts has more than doubled the production of high-frequency inductive heating generators. With inductive heating, it is possible to harden steel surfaces to any desired depth and width. A shaft can be hardened at places where it must resist wear without hardening the entire piece and thereby destroying its toughness.

The steel to be heated is placed within a coil to which a high-frequency generator is connected. The rapidly varying magnetic field induces eddy currents in the metal, causing it to become heated. The effect is unique in that one could insert one's hand in the coil without burning it; yet a piece of steel becomes hot within a few seconds when inserted in the coil.

Silver Adds Important Properties to Copper Alloys

By alloying copper with small percentages of silver, many advantages are gained. Silver is especially useful in copper that is to be soldered, as the heat does not cause an undue softening of such an alloy. In commutator bars, for example, a small percentage of silver insures the maintenance of hardness. A welding rod containing 1 per cent of silver and a trace of deoxidizer, the remainder being copper, is suitable for copper welding. Some commercial copper alloys intended for high electrical conductivity contain about 1 per cent of silver, 96 per cent or more of copper, with small percentages of such hardening elements as beryllium, cobalt, cadmium, or tin. Since silver is not one of the "critical" metals, its use is not restricted.

EDITORIAL COMMENT

American industry has performed a remarkable feat in the manufacture of war materials. Many plants are far ahead of the original production schedules. Industry as a whole has produced more than anyone expected, and, at present, many plants are limited only by the supply of raw materials. It is encouraging to know that the industries of the country that so efficiently produced for the peacetime needs of the nation are doing an equally outstanding job in producing for wartime requirements. More than anything else, this has created confidence in the outcome of the war and in the future of America.

An Industry that has Surpassed All Expectations

While it is difficult to say that credit for the most remarkable performance should go to any one industry, since several of our industrial groups have done exceptionally well, there is no question but that the most spectacular performance is that of the great aircraft industry, which, in the last three years, has grown from comparatively small beginnings to enormous proportions. The vision, the courage, the enterprise of aircraft manufacturers and engineers have focused upon this industry the attention of the entire nation. Here is an industry that produces war equipment which is, perhaps, the most essential of all in modern warfare; and it is now producing this equipment in quantities that only a year ago were considered impossible.

It will be the fighting men in the air, in the front lines, and in our ships at sea that will ultimately decide the issue; but just as the war equipment would be useless without the courage and ability of these men, so these men would be helpless to win the war without the products of American industry.

In paying this tribute to an outstanding performance of American manufacturers and engineers, reference should also be made to the machine tool industry, which has so rapidly and efficiently equipped the war production plants with the machinery necessary to produce the implements of war; for this industry is today producing at a rate equal to six times its capacity of three years ago.

When the war is over and victory belongs to the Allied Nations, the enterprise, courage, hard work, and successful performance of American manufacturers and engineers will be a matter for history to record; because without their ability and efforts, the future of free nations could not have been assured.

War Production Needs Foster New Ideas in Design

The engineering thought and ingenuity expended in speeding up war material production is certain to influence machine design and mechanical procedure in the future. In many shops, because of changing from one line of manufacture to another, men engaged in mechanical work have found new methods that will gradually supersede older procedure. This is true of both design and shop practice. For example, it is quite likely that after the war, automobile engine design will be influenced to some extent by the contact that the automobile engineers have had with aircraft engine design.

In the machine tool and shop equipment field, engineers are discussing subjects that formerly presented no serious problem to them. It has been found desirable to simplify designs, so that machines can be easily and safely operated by men and women of comparatively little mechanical training. Also, it has become desirable to simplify the mechanisms of certain types of machines in order to make the matter of maintenance and repairs as free from complications as possible, since service men are not now available to the extent that they formerly were, and machinists on the spot must be able to take care of breakdowns.

For many years, machine designers have been chiefly concerned with the productivity of their machines. The problem has been to reduce operating time. Now a number of additional problems present themselves. Reducing operating time is just as important as it ever was—or even more so; but these other problems of simplicity and ease of operation, ruggedness and dependability, ease of maintenance and simplicity of repairs, have now become equally important.

Ingenious Mechanical Movements

Mechanisms Selected by Experienced Machine Designers as Typical Examples Applicable in the Construction of Automatic Machines and Other Devices

Mechanism for Fastening Panels and Cowling to Airplane Fuselage

Sheet-metal panels, hand-hole plates, cowls, and other parts that must be removed from the fuselage of an airplane to permit inspection or servicing require some means of fastening that will hold them securely in place, yet allow quick removal or replacement. A simple fastening developed by the Moran Aircraft Engineering Co., Freeport, N. Y., to meet these requirements comprises the ingenious lock-stud mechanism shown in the accompanying illustration.

The illustration shows the principle on which the lock-stud mechanism operates; the actual design of the stud and locking members, however, can be varied somewhat to suit the specific requirements. This fastening device can also be used to advantage in other fields, as for example, for fastening panels, inspection plates, and guards on machine tools. The complete locking device consists of five parts—the stud *C*, retaining ring *D*, spring *E*, and studs *F* and *G*.

Fig. 1 shows the head of one of the lock-studs *C* used to fasten a sheet-metal panel *B* to the metal fuselage *A* of an airplane. With this particular assembly, the stud remains attached to panel *B* when the latter is removed. Thus, when the panel is to be replaced, it is only necessary to enter the studs in their corresponding holes, press the panel into place, and then give each stud a quarter turn with a screwdriver or coin inserted in the slot in the stud head. This action allows the two arms of spring *E*, Figs. 3 and 5, to snap into grooves *H* in the sides of stud *C* and hold it securely in place.

Fig. 1 shows stud *C* with the slot in its head at right angles to center line *X–X*, this being the position in which the stud can be passed through the corresponding hole in fuselage *A*. Simply giving the stud one-quarter turn, as shown in Fig. 2, serves to lock the panel to the fuselage. The locking of the stud can be accomplished by a quarter turn in either direction.

As shown in cross-section *X–X*, Fig. 3, panel *B* is indented or dimpled to fit into a similar de-

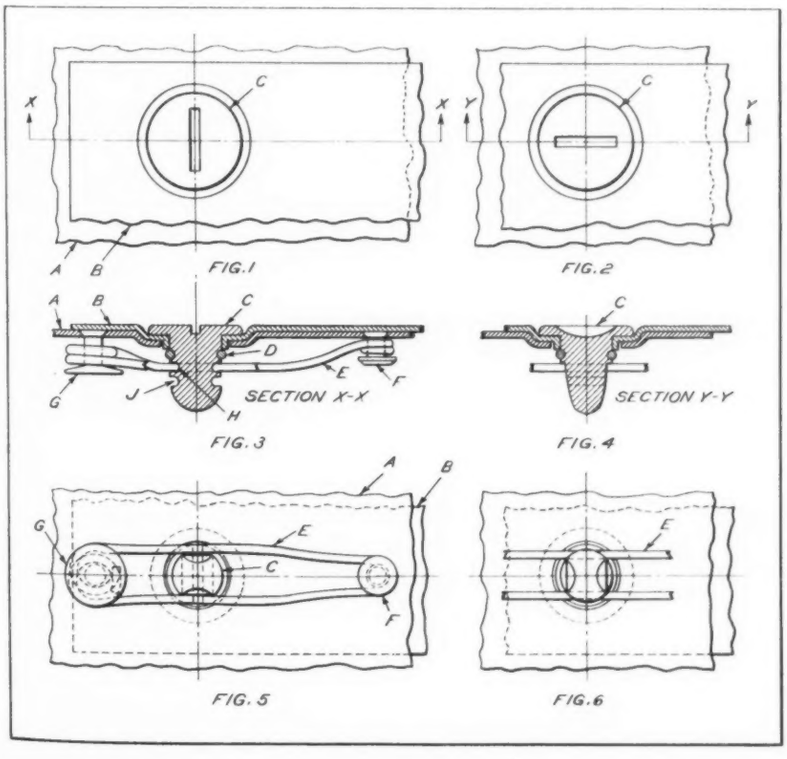


Fig. 1. Panel B to be Locked to Airplane Fuselage A by Lock-stud C

Fig. 2. Stud C Turned to Locking Position

Fig. 3. Cross-section of Lock-stud C, Panel B, Fuselage A, and Locking Spring E, with Stud C in Unlocked Position

Fig. 4. Stud C in Locked Position

Fig. 5. Plan View, Showing Spring E with Stud C Inserted, but in Unlocked Position

Fig. 6. Arms of Spring E Shown Snapped into Grooves H (Fig. 3) in Order to Hold Stud C in Place

pression in fuselage *A* and to bring the head of the lock-stud flush with the outer surface of the panel. Stud *C* is retained in the hole in panel *B* by a split ring *D*, which is sprung into place in a groove in the stud. Ring *D* bears on the end of the flange of the hole in panel *B* and serves to keep the stud assembled to the panel when the latter is removed from the fuselage.

Spring *E*, which locks stud *C* in place, is held in position on fuselage *A* by studs *F* and *G*, which are riveted or welded to the fuselage. A plan view of spring *E* is shown in Fig. 5. This spring has a coil at one end similar to that at the end of a safety or blanket pin. The coil is so wound, however, that the tension tends to close the opposite ends or arms rather than spread or open them, the normal action of the spring, therefore, being to grip stud *C*.

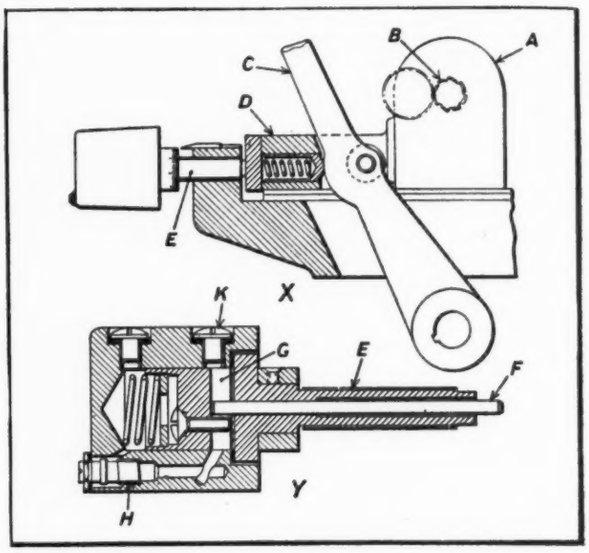
The coiled end of spring *E* is held in position by stud *F*. The ends of the two arms of spring *E* opposite the coiled end are each formed into a loop, the inside diameter of which is considerably larger than the body of stud *G* while the outside diameter is about the same as the diameter of the head of stud *G*. This construction allows the outer ends of the spring to be forced or sprung apart when stud *C* is inserted.

Referring to Figs. 3 and 5, the sides of stud *C* parallel with the arms of spring *E* are milled off or flattened, as indicated by cross-section *Y–Y*, Fig. 4. The flattening or tapering of the stud sides permits it to be inserted between the arms of spring *E*, as indicated in cross-section *X–X*, Fig. 3. The sides of the stud at right angles to the flattened sides have parallel grooves *H* and *J* in them. Thus, when stud *C* is given a quarter turn to the right or left, the arms of spring *E* snap into grooves *H* under spring tension and hold the rivet securely in place.

The second set of grooves *J* is provided for use in cases where two thicknesses of metal or paneling are to be fastened to the fuselage. Fig. 6 shows the arms of spring *E* after they have snapped into the locking position in the parallel grooves in stud *C*. The pressure of the spring in the parallel grooves prevents the stud from turning or being withdrawn until it is turned by means of a screwdriver or other tool to bring the flattened sides parallel and in contact with the arms of spring *E*.

Controlled In-Feed Mechanism for Screw Milling Machine

The accompanying illustration shows a dashpot designed to retard the rate of movement of the in-feed of a screw milling machine with a backed-off hob type cutter. The object of this device is to prevent the hob from jumping forward during the movement from one tooth to the next, so that smoother operation, with a uniform controlled in-feed, is obtained.



Dashpot Mechanism Designed to Retard the Rate of Movement of Milling Machine In-feed

In view *X*, cutter-slide *A* houses a spindle carrying the hob *B*. Lever *C* operates the cutter-head and is extended to form a handle (not shown). In the arrangement illustrated, part *D* is integral with the cutter-head. Movement of lever *C* advances the hob toward the work until contact is made with stop-screw *E*, which is adjustable for depth of cut.

Referring to view *Y*, control rod *F* is shown in contact with a piston contained in cylinder *G*. The oil or other suitable fluid behind the piston escapes through an adjustable needle valve *H* by way of suitable passages, at a rate determined by the setting of the needle valve. After completion of an operation, the oil returns through a valve to the other side of the piston under the influence of the return spring. Screws *K* act as filling plugs.

When slide *D* comes into contact with stop-screw *E*, it will meet the central rod *F*, and its rate of progress will be limited by the rate at which oil or other fluid can escape through the needle valve. The spring and plunger shown in the view at *X* provide a slight additional movement of lever *C* after contact with screw *E*, as required, to permit the operation of a trip motion.

B. M.

* * *

In a single month, the Westinghouse Electric & Mfg. Co. reclaimed enough aluminum from machine shop scrap to build ten Army bombers. After pure aluminum and copper are removed from the scrap, the rest is melted into ingots.

RECOMMENDED TOOL ANGLES FOR CARBIDE TOOLS—1

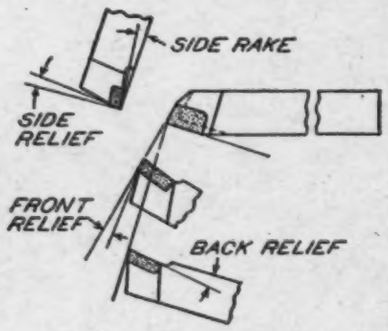


FIG. 1

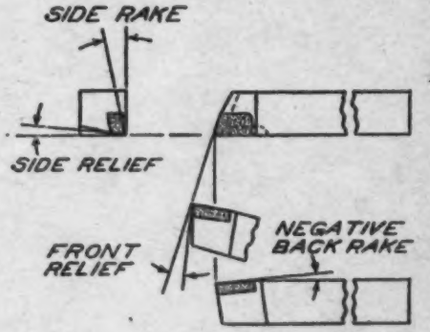


FIG. 2

Material	Relief (Degrees)*		Rake (Degrees)*	
	Front	Side	Back	Side
Steel Cutting (For Average Work)				
S A E 1010–1025	6–12 (7)	6–12 (7)	0–15 (0)	8–15 (8)
S A E 1030–1095	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 1112–1120	6–12 (7)	6–12 (7)	0–15 (0)	8–15 (8)
S A E X1314–X1340..	6–12 (7)	6–12 (7)	0–10 (0)	4–12 (8)
S A E T1330–T1350..	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 2015–2320	6–12 (7)	6–12 (7)	0–15 (0)	8–15 (8)
S A E 2330–2350	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 3115–3130	6–12 (7)	6–12 (7)	0–15 (0)	8–15 (8)
S A E 3135–3450	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 4130–4820	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 5120–52100 ...	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
S A E 6115–6195	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
Cast Steel	5–10 (7)	5–10 (7)	0–10 (0)	4–12 (8)
For Large Work where Slow Cutting Speeds and Heavy Feeds are Used				
S A E 1010–1025	6–10 (6)	6–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 1030–1095	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 1112–1120	6–10 (6)	6–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E X1314–X1340..	6–10 (6)	6–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E T1330–T1350..	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 2015–2320	6–10 (6)	6–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 2330–2350	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 3115–3130	6–10 (6)	6–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 3135–3450	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 4130–4820	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 5120–52100 ...	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
S A E 6115–6195	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)
Cast Steel	5–10 (6)	5–10 (6)	0–6 Neg. (0)	6–10 (6)

*Figures in parentheses are "safe" starting angles on new jobs. The other figures indicate the range of practical angles.

Compiled by Carboloy Company, Inc.

RECOMMENDED TOOL ANGLES FOR CARBIDE TOOLS—2

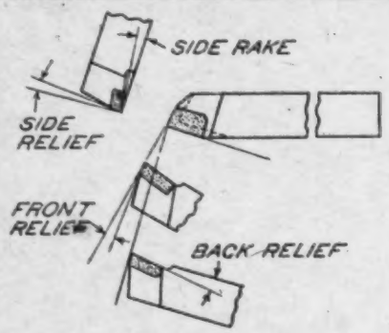


FIG. 1

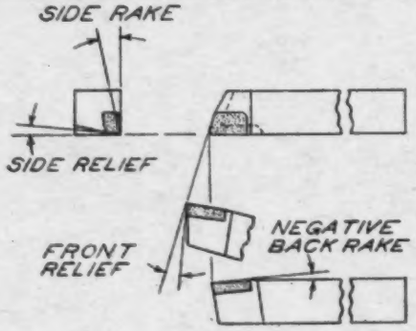


FIG. 2

Material	Relief (Degrees)*		Rake (Degrees)*	
	Front	Side	Back	Side
Cast Iron (For Average Work)				
Hard	4–6 (5)	4–6 (5)	0–6 (0)	0–10 (5)
Medium	4–8 (7)	4–8 (7)	0–6 (0)	0–10 (8)
Soft	4–10 (7)	4–10 (7)	0–6 (0)	0–12 (8)
Hard (Alloy)	4–6 (5)	4–6 (5)	0–6 (0)	0–8 (5)
Medium (Alloy)	4–8 (7)	4–8 (7)	0–6 (0)	0–10 (8)
Soft (Alloy)	4–10 (7)	4–10 (7)	0–6 (0)	0–10 (8)
Up to 25 Per Cent Semi-Steel	5–8 (7)	5–8 (7)	0–6 (0)	5–10 (8)
Over 25 Per Cent Semi-Steel	4–8 (7)	4–8 (7)	0–6 (0)	5–10 (8)
Brake Drums	4–8 (7)	4–8 (7)	0–6 (0)	0–10 (8)
Chilled Rolls	3–5 (3)	3–5 (3)	0–0 (0)	0–5 (0)
For Large Work where High Cutting Speeds are Not Practical				
Hard	4–6 (4)	4–6 (4)	0–6 (0)	0–8 (6)
Medium	4–6 (4)	4–6 (4)	0–6 (0)	0–8 (6)
Soft	4–6 (6)	4–6 (6)	0–6 (0)	6–12 (8)
Hard (Alloy)	4–6 (4)	4–6 (4)	0–6 (0)	0–6 (4)
Medium (Alloy)	4–6 (4)	4–6 (4)	0–6 (0)	0–8 (6)
Soft (Alloy)	4–8 (6)	4–8 (6)	0–6 (0)	6–12 (8)
Up to 25 Per Cent Semi-Steel	4–8 (6)	4–8 (6)	0–6 (0)	6–12 (8)
Over 25 Per Cent Semi-Steel	4–8 (6)	4–8 (6)	0–6 (0)	4–10 (8)
Brake Drums	4–8 (6)	5–8 (6)	0–6 (5)	0–10 (8)
Chilled Rolls	3–5 (3)	3–5 (3)	0–0 (0)	0–5 (0)
Aluminum Castings and Bar Stock and Zinc Die-Castings				
All	6–10 (7)	6–10 (7)	5–15 (10)	8–15 (8)

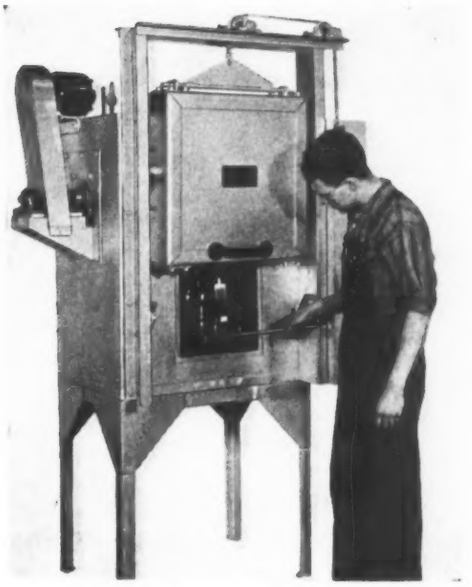
*Figures in parentheses are "safe" starting angles on new jobs. The other figures indicate the range of practical angles.

Compiled by Carboloy Company, Inc.

Selecting Oven Type Heat-Treating Furnaces

Characteristic Features of Gas and Electric Oven Type Furnaces Used for Heat-Treating Tool Steels and for Various Other Heat-Treating Operations—Third of a Series of Four Articles

By HOLBROOK L. HORTON



Despatch Heavy-duty Oven Type Electric Furnace for Low-temperature Heat-treating

IN general, the construction of electric oven type furnaces closely resembles that of the gas type, with the exception of the provision for heating. In the electric furnace, resistors of a suitable alloy are located in the side walls, floor, or roof of the heating chamber, and in some types, on the rear wall and the door. Because of the absence of flames and burning gases, a relatively clean work surface can be maintained. The presence of air in the heating chamber may, however, lead to some scaling or decarburization, so that where the carbon content of the steel is to be maintained exactly, or where some carburizing treatment is to be given, provision must be made for supplying a special atmosphere for this purpose.

Another fact which must be taken into consideration is that electric heating elements, over a period of use, will lose weight by oxidation. This results in a gradually increasing resistance to the passage of electric current, due to the cross-section of the element becoming smaller. Consequently, some reduction in the furnace heating capacity will occur, and a longer time will be required for heating during the latter part of the useful life of the heating elements. No definite statement can be made concerning the length of life of heating elements, since this varies in different furnaces. Some manufacturers give the minimum length of life for the heating elements as 1000 hours; others, as 800 hours. Replacement of old elements can usually be made very easily.

For hardening carbon steel, annealing, or preheating and drawing high-speed steel in the low-temperature range of from 1000 to 1800 degrees F., several electric furnaces are available. One of these has front plate, back plate, and legs of gray-iron castings, and sides, top, and bottom of reinforced steel plates. Nickel-chromium alloy resistors located on the side walls and floor of the heating chamber are so arranged as to provide uniform heat distribution. The inner wall of the furnace is built of insulating brick, and between this and the outer casing is a packing of insulating material. The hearth is of silicon carbide, and is mounted with heat-radiation space below and at the sides to promote temperature uniformity. A 1 1/2-hour period is usually required to raise the temperature of the heating chamber from 50 to 1600 degrees F. when empty.

A counterbalanced door is provided which, in the smaller sizes, is operated by hand, and in the larger by a foot-treadle. Auxiliary equipment for automatic temperature control and automatic timing can be obtained. The furnaces range in size from that with a heating chamber 6 1/4 inches wide by 6 inches high by 9 inches long, having a maximum rating of 4 kilowatts, to that with a heating chamber 24 inches wide by 18 inches high and 36 inches long, with a maximum rating of 42 kilowatts. The smallest size is a bench type, while the others are floor-mounted. In all sizes, the depth of the furnace chamber can be doubled at an additional cost.

For tempering, drawing, and other heat-treatments within the temperature range of 275 to 1250 degrees F., a series of furnaces with forced-air circulation are available. A high-capacity,

heavy-duty alloy fan forces large volumes of heated air through the furnace to insure uniform heat-treatment. Either horizontal or vertical flow of air can be provided. Depending upon the size of furnace, there are up to 350 recirculating air changes per minute.

The furnace body is of heavy steel, reinforced by structural members. Six inches of high-temperature insulation are provided. The door is self-aligning and tight-sealing. On the smaller sizes, it is operated by means of a handle on the counterweight, while on the larger sizes a pull-chain is used. In the different sizes, the heating chamber ranges from 13 by 13 by 13 inches to 37 by 25 by 37 inches. The heater capacity of the smallest size is 9 kilowatts, and of the largest 30 kilowatts.

Another electric furnace for low-temperature work is of welded-steel construction, mounted on angle-iron legs for floor duty. The furnace front has close-fitting grooves on each side for the sliding lip of the door, and there is a sand seal at both top and bottom. The doors are hand-operated, except in the two largest sizes, for which motor operation of the doors may be furnished. A steel loading shelf is provided which, on the larger sizes, is automatically raised and locked in a horizontal position when the door is raised, and dropped down to a vertical position when the door is lowered.

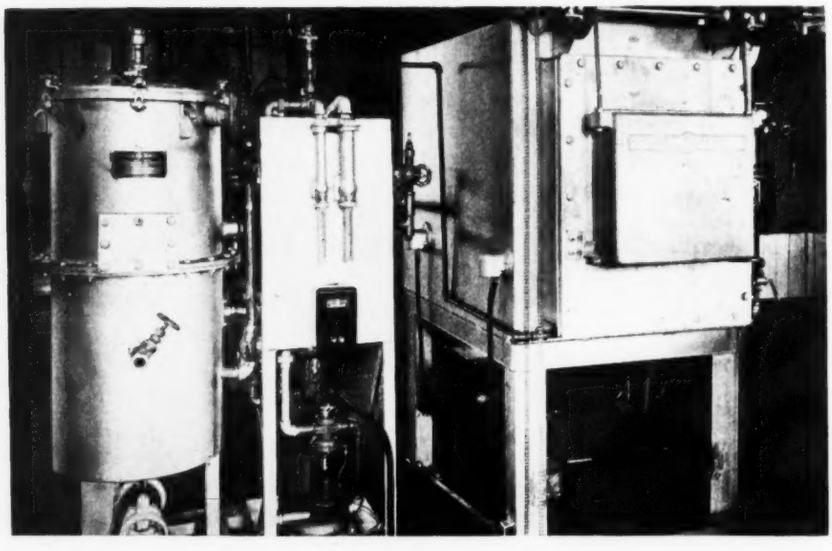
In the two smallest sizes, two heating units are provided, one beneath the hearth and one at the top of the chamber, above the upper line of the door opening. In the larger sizes, three heating units are used, one beneath the hearth and one on each side wall. The units are so located as to provide uniform heating throughout the furnace chamber. A heating period of seventy-five minutes for the smallest size and twenty-five minutes for the largest size is required to reach a temperature of 1500 degrees F., where the furnace has been in use the previous day. These furnaces range in size from that having a heating chamber 12 inches wide, 24 inches long, and 9 inches high, with a connected load rating of 11 kilowatts, to that having a heating chamber 36 inches wide, 72 inches long, and 23 inches high, with a connected load rating of 72 kilowatts. The two smallest sizes operate on single-phase power supply at 75 and 110 volts, respectively; the larger sizes operate on a three-phase, 220-volt supply.

Furnace Designed for Tool-Room Duty

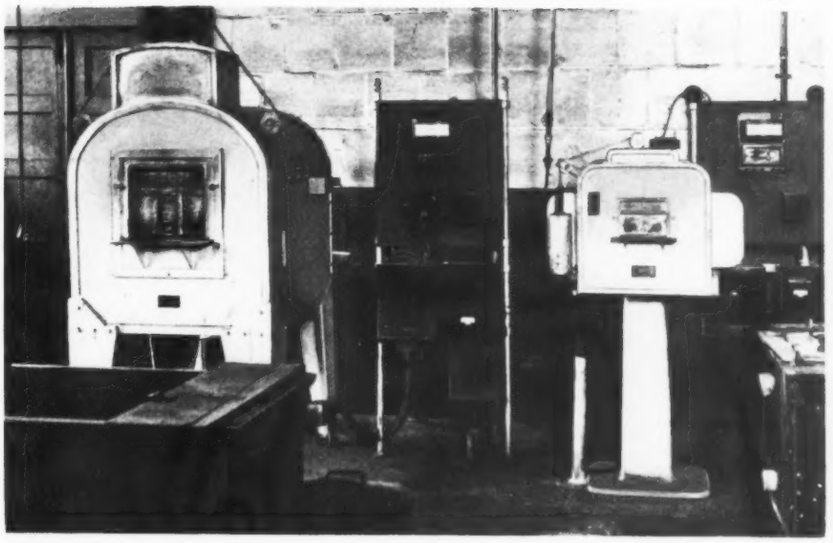
Suitable for light or intermittent tool-room or laboratory duty for annealing, hardening, tempering, normalizing, and box carburizing is a small oven furnace made of sheet steel and having a maximum operating temperature of 1850 degrees F. The heating elements are placed on the top, bottom, and sides of the furnace chamber, and are supported by studs made integral with and placed on the back of perforated ceramic muffle plates. Heating element connections are made at the rear, the terminals and connectors being protected by a metal screen. The two smaller sizes are designed for bench mounting; the larger for floor mounting.

A smooth, cast, nickel-chromium hearth plate is used, which evenly distributes the heat from the bottom element and protects it from injury. The door is counterbalanced and slides in adjustable guides. The two smallest furnaces operate at element voltages of 26 and 58, respectively. Transformers are, therefore, used to effect connection with the regular 110- or 220-volt supply line.

The next larger size operates at 110 volts, and the largest size operates at 220 or 440 volts. When furnace transformers are supplied, a tap changing switch and reduced voltage taps per-



General Electric Protective-atmosphere Oven Type Electric Furnace for the Scale-free Hardening of Steel without Decarburization. Atmosphere Producing Equipment is Seen at Left



(Left) Sentry Medium-temperature and (Right) Small High-temperature Oven Type Electric Furnaces. The Latter is Capable of Continuous Operation at 2750 Degrees F.

mit close temperature regulation. These furnaces range in size from that with a door opening 4 inches wide by 3 inches high, and a heating chamber 10 inches long, to that with a door opening 11 inches wide by 7 1/2 inches high, and a heating chamber 21 inches long. The smallest has a connected capacity load rating of 1.9 kilowatts, and the largest 8 kilowatts.

Auxiliary Burners Provide Gas Atmosphere

Specifically designed for general heat-treating operations in a protective atmosphere at temperatures up to 1900 degrees F. are two electric furnaces with auxiliary gas supply. The heating chamber lining consists of preformed insulating refractory backed with one layer of insulating brick and a second layer of block insulation. Heavy nickel-chromium elements of the ribbon type are used, and these are readily removable through the door opening of the furnace. Hand, foot-treadle, or air-cylinder operation of the door is available.

An atmosphere control "curtain" for the heating chamber is provided by the use of a slot type burner extending the full width of the furnace throat. This forms an effective barrier to the entrance of free air, and also insures a protective atmosphere for the work. The height of this control "curtain" is synchronized with the height of the door opening. An adjustable vent in the rear of the furnace enables the flow of gases to be readily controlled. Mixing valves and manometers are provided, so that the correct amount of air and gas can be premixed before going to the burners. Dehydrating cylinders remove excess moisture from the gases. Automatic time and temperature controls are available.

These furnaces are made in two sizes. One has an effective hearth area of 12 by 24 inches, and a door opening of 10 inches. It has a rating of 10 kilowatts. The other has an effective hearth area of 16 by 30 inches, and a door height of 12 inches. It has a rating of about 18.5 kilowatts. Both furnaces can be obtained for operation either on a 230-volt single-phase power supply or on a 115-volt three-phase power supply.

Furnaces for Heat-Treating Without Scale or Decarburization

Designed to be used with a special atmosphere consisting of a mixture of nitrogen and carbon monoxide is a series of four furnaces for heat-treating without scale or decarburization. A light-weight refractory lining backed by heat-insulating material is provided, and this is enclosed by a welded gastight sheet-steel casing. A high-velocity flame curtain prevents the furnace from losing its atmosphere while the door is open. An unusual feature of this curtain is the mounting of the gas burner at the top of the furnace throat, so that the flame curtain is shot down over the door opening, eliminating the possibility of dirt dropping into and clogging the gas burner.

These furnaces are suitable for heat-treating operations requiring temperatures ranging up to 2000 degrees F. The sizes range from that with a door opening 12 inches wide by 8 inches high and a hearth 27 inches long to that with a door opening 27 inches wide by 20 inches high and a hearth 54 inches long. The smallest has a rating of 15 kilowatts, and the largest 50 kilowatts. The three smaller furnaces operate at 35, 44, and 70 volts, respectively, while the largest operates on a 220-volt three-phase line. For the low-voltage types, air-cooled transformers are available for connection to 110, 220, 440, or 550-volt power lines.

How to Get the Most Out

Directions that will Make it Possible to Keep Belt-Driven Machinery in Continuous Service under Wartime Conditions

IN order that belt-driven machines may operate continuously, the belt drive must also operate continuously and deliver the full power of the motor or lineshaft to the driven machine. Neither flat leather belts nor V-belts are difficult to maintain provided the few simple rules given in the following are observed.

1. *Keep Leather Belts Dressed*—Leather belts must be kept dressed to prevent their fibers from drying out. They must also be kept clean. They should be dressed with good leather belt dressing every three months for ordinary conditions, and every month or every week where the air is dusty or very dry, or the belts overloaded. To clean a belt, wipe off the dirt with waste dipped in gasoline. Let the belt dry and then dress it. Naphtha or carbon tetrachloride are also satisfactory for belt cleaning.

2. *Make All Leather Belts Endless*—Endless belts last longer and avoid fastener troubles. A millwright can be instructed how to make endless laps by the belt supplier, or the supplier will do it if requested. In cases where many leather belts are used, it is advisable to buy the required clamps and rods and obtain a book of instructions. Then endless belts can be made on the pulleys.

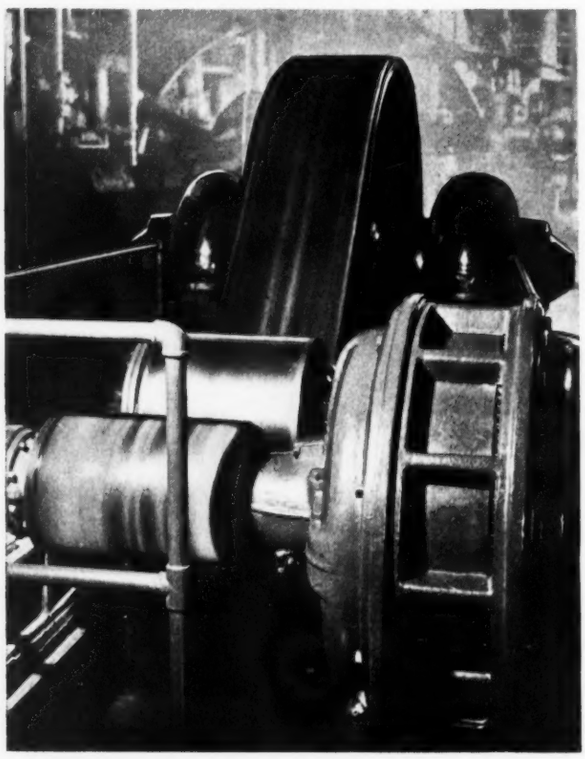


Fig. 1. A 150-H.P., 870-R.P.M., Compressor Drive with Idler. The Double Bending of the Belt Wore out the Belt Rapidly

3. *Be Sure the Belt Thickness is Correct for the Pulley Diameter*—The accompanying table gives the minimum pulley diameters for leather belts of different thicknesses. Do not use belts on pulleys smaller than specified, as this is certain to cause trouble.

Minimum Pulley Diameters, in Inches, for Various Types of Belts

	Single-Ply		Double-Ply			Triple-Ply	
	Med.	Heavy	Light	Med.	Heavy	Med.	Heavy
	Minimum Pulley Diameters, Inches						
Belts under 8 Inches Wide	3	5	6	8	12	..	..
Belts 8 Inches and Wider	..	..	8	10	14	24	30

4. *Be Sure the Belt is of the Right Size for the Load*—To have belt-driven machinery work properly, the machine must be provided with enough continuous and dependable power to handle peak loads, no matter how frequent or severe these loads may be. A belt large enough for this purpose must be provided.

If lineshaft belts and long-center belt drives do not seem to work properly, check the belt size. Belt manufacturers will gladly supply users with the American Leather Belting Association 1939 horsepower table. The width and thickness of the belt can be checked from this table.

Short-center belt drives are recommended only in connection with an automatic belt-tightening motor base (a pivoted motor base) used in place of motor slide rails. When pivoted bases are used, the belt drive is efficient, the belt lasts a long time, and there is practically no need for maintenance. Belt suppliers will provide users with the Short-Center Leather-Belt Drive Data Book. This book gives complete tables, by means of which any short-center leather belt drive can be quickly checked up.

# of Belting

By J. R. HOPKINS, Engineering Department
Chicago Belting Co., Chicago, Ill.

For short-center drives be sure to have large enough pulleys to obtain the right belt speeds. Doubling the belt speed doubles the horsepower a belt will transmit with the same stress in the belt, or cuts in half the stress in the belt for the same horsepower. The diameter of the motor pulley must not be smaller than that recommended by the motor manufacturer. Nearly all unsatisfactory short-center belt drives are caused by the pulley being too small. The National Electrical Manufacturers Association (NEMA) has published tables for minimum motor pulley diameters.

The need for reference to the Short-Center Leather-Belt Drive Data Book cannot be too thoroughly emphasized. If the directions in this book are followed, the drives should be satisfactory, should require scarcely any maintenance, and the belt life should be very long.

How to Get the Most Out of V-Belt Drives

1. In designing a new installation, always use larger sheaves than the minimum specified by the manufacturers, and use an extra belt or two above the minimum number required. The additional cost is offset by the considerably longer belt life obtained.

2. Be sure to purchase matched sets of belts, so that each belt will carry its full share of the load.

3. Do not force or pry the belts over the sides of the grooves. Slide the motor forward to put the belts on, and then slide it back to provide tension. Use a pivoted motor base under the motor; then the belts will go on easily and they will be maintained at the right tension while running.

4. Proper alignment of the sheaves is highly important for long V-belt life. Be sure that the sheaves are lined up in both the horizontal and vertical planes. If the two sheaves of a V-belt drive are not properly lined up, it is obvious that the ropes will scrape on one side of the grooves as they enter the driven pulley, and similarly scraping will take place on the other side of the grooves when they enter the driver. This constant scraping action greatly reduces belt life.

5. V-belts must be kept tight. If a pivoted motor base is not used, check the tension thirty-six hours after the original installation has been made, and at frequent intervals thereafter, to make sure that the belts have a live, springy vibration when struck by the hand.

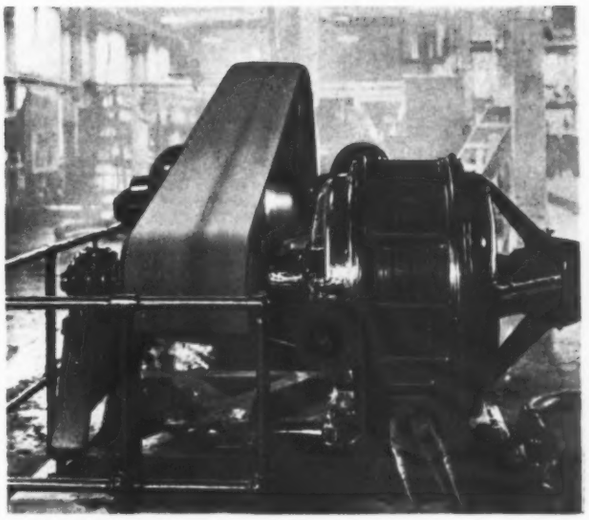


Fig. 2. Drive Shown in Fig. 1, with the Idler Removed and an Automatic Belt-tightening Motor Base Provided. Belt is Shorter, Costs Less, Wears Longer, and Saves Power

6. Inspect the sheave grooves to make sure that they are smooth and not worn out of shape. If they are worn, replace the sheave with a new one.

7. Keep V-belts clean—free from dirt, grease, and oil. No belt dressing is necessary; just wipe the belt with cloth or waste dipped in gasoline.

8. Never replace part of a set of V-belts with new ones. Replace the whole set with new V-belts, and save the old ones for "spares" to be used with other old ones.

* * *

Motion Picture Demonstrations in Shop Entertain and Instruct

At one of the General Electric Co.'s plants, motion pictures of animated drawings are used to show the employes how the mechanism or part that they produce functions in the complete assembly. In one instance, for example, the operation of a magne-blast circuit-breaker is visualized. The demonstration takes two minutes. A series of colored lights and arrows displays the path of the arc from the parting of the breaker contacts through its ever lengthening pattern. Synchronized with this visual demonstration is the commentator's voice, explaining every step during the circuit-breaker's complete opening and closing operation. These pictures are shown during the lunch hour and provide not only relaxation and entertainment, but valuable instruction as well.

MATERIALS OF INDUSTRY

THE PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

Self-Lubricating Porous Iron Bearings

The Keystone Carbon Co., Inc., 1935 State St., St. Marys, Pa., has announced the addition of "Selflube" porous iron bearings to its line of self-lubricating bronze bearings. The new porous iron bearings, introduced to conserve copper, are stronger than porous bronze bearings, and they are interchangeable with them in most applications.

These bearings are made from powdered iron which is molded to the size and shape desired, then baked, and finally saturated with a good grade of oil. They have an average porosity of 25 to 35 per cent, so that a large amount of oil is available to form a protective, continuous oil film on the bearing surfaces. In many instances, this oil reserve lasts the entire life of the application, eliminating the use of oil vents or grease cups. Additional lubrication is recommended for heavy-duty or continuous-operating units.

The new bearings have a low coefficient of friction which, together with their self-lubricating qualities, prevents excessive temperature, speed reduction, noise, and scoring of shaft. As in the case of "Selflube" bronze bearings, they are molded to close dimensional tolerances..201

Anti-Rust Oil for Protecting Metal Surfaces

An anti-rust oil known as "Miccroil" has been introduced on the market by the Michigan Chrome & Chemical Co., 6340 E. Jefferson Ave., Detroit, Mich., for the protection of metal surfaces subject to corrosion. The oil contains 42.5 per cent total solids, and is of a consistency that assures a uniform, protective film over the entire surface. It is applied by hand dipping, and can be wiped off or removed with a solvent.

In a series of tests, steel panels coated with "Miccroil" were subjected to the corrosive action of acid fumes in a typical plating plant, where the relative humidity varied from 92 to 96 per cent at 87 degrees F. At the end of a month, no appreciable change could be seen in the protected surface. No deterioration was shown after forty-eight hours in a continuous spray of 20 per cent salt solution, with the relative humidity at 96 per cent and the temperature 80 degrees F. Neither could any change be noted after four weeks of exposure to the weather on the roof of a Detroit plant during the month of January. 202

Lubricant for Drawing, Stamping, or Forming Nickel Alloys

A new lubricant for use in drawing, stamping, or forming nickel alloys has recently been placed on the market by the Glyco Products Co., Inc., 230 King St., Brooklyn, N. Y., under the name of Diglycol Stearate S. This product is a white, wax-like solid, dispersible in water, and has a melting point of 51 to 54 degrees C. It will fire off completely at any annealing temperature (400 degrees F. minimum) in an atmosphere of oxygen or hydrogen.

As an example of its use, a 5-inch square flat plate made of an alloy composed of 78 per cent nickel and 4 per cent magnesium, copper, and iron was drawn with a 2 per cent dispersion of Diglycol Stearate S as follows: First draw—2 inches deep, 1 1/2-inch diameter (anneal); second draw—3 inches deep, 1-inch diameter (anneal).

For drawing and stamping, a 1 per cent concentration sprayed on usually provides adequate lubrication. Even smaller concentrations can generally be used as coolants in stamping operations. 203

New Sweeping Compound Removes Oil and Grease from Floors

An asbestos sweeping compound designated the Carey "Grease Ball" has been developed by the Philip Carey Mfg. Co., Cincinnati, Ohio, for removing oil and grease deposits from floors and driveways. The compound contains no acids or caustics and will not cause erosion. It eliminates the danger of slipping and of fire due to oil and grease accumulations.

To obtain additional information about materials described on this page, see lower part of page 234.

The compound is applied by sprinkling it on the grease or oil. Heavy grease may first require soaking with kerosene. Scrubbing with a broom causes the compound to absorb the oil and grease, which can then be swept away. A further advantage of this compound is that it can be re-used until thoroughly saturated...204

Substitute for Tin Hardens Bronze Castings

A metal known as P-M-G Hardener, produced by the Phelps Dodge Copper Products Corporation, 40 Wall St., New York City, is being widely used as a substitute for tin in the production of bronze castings formerly having an 8 to 10 per cent tin content. Such castings conform fully to U. S. Navy Specification 46-B-28 and U. S. Federal Specification QQ-C-593, which permit the use of this hardener in the place of tin..205

Magnesium Alloy that Contains Silver

According to the American Silver Producers' Research Project, 82 Fulton St., New York City, a magnesium alloy containing 2.6 per cent each of aluminum and zinc; 5.5 per cent silver; and 0.2 per cent manganese, with the remainder magnesium, has a specific gravity of only 1.89. This alloy, in extruded bars, rolled sections, and large forgings, is said to have the following physical properties after heat-treatment: Tensile strength, from 40,000 to 65,000 pounds per square inch; yield strength, 32,000 to 50,000 pounds per square inch; elongation in 2 inches, 2 to 10 per cent; Brinell hardness, 80 to 95. This magnesium alloy has a corrosion resistance comparable to all except the most corrosion-resistant of commercial magnesium alloys. 206

Compound to Prevent Window Glass from Shattering

Flying pieces of window glass broken by vibration have been responsible for large numbers of casualties during bombing raids. To aid in preventing such injuries, a transparent protective coating for windows has been developed by the Maas & Waldstein Co., Newark, N. J.

Window glass or plate glass treated with this new coating, which is known as "Glasshield," is, in effect, turned into safety glass. A coated pane may break as the result of vibration, but it will not shatter, according to the manufacturer. It is also stated that the coating does not interfere with vision or light transmission through the glass.

Two coats of "Glasshield" on the inside surface of a window pane are effective, but, for maximum protection, the outside surface should be similarly treated. The coating is applied with a brush, allowing an hour for the first coat to dry before the second one is put on. When no longer wanted, the coatings can be removed with a razor blade.....207

Durez 11863—A Low Power Factor Molding Compound

A new phenolic molding compound having a very low power factor (0.07 at 1000 K.C.) and high dielectric breakdown and fatigue strength has recently been introduced on the market by Durez Plastics & Chemicals, Inc., of North Tonawanda, N. Y. This material was especially developed for radio parts, such as condensers, crystal holders, etc. It has been named "Durez 11863," and is said to have excellent moldability, being easy to handle in compression molds. It is available in one color—natural. 208

Plastic Fittings Now Being Made Commercially

Fittings made from the thermoplastic "Saran," fabricated by the Acadia Synthetic Products Division of the Western Felt Works, 4115 Ogden Ave., Chicago, Ill., are now available for tubing sizes from 1/8 to 3/8 inch outside diameter. This company also makes tubing, pipe, rods, and sheets from "Saran." By means of the new fittings, it is possible to install complete chemically resistant piping systems without the use of metal, thus providing a substitute for materials urgently needed for war purposes. These fittings are said to have a high tensile strength, to be non-corroding and non-aging. They are non-conductors of electricity.....209

Blackout Coating for Exterior Applications

A non-reflective, completely opaque blackout compound for application to the exterior surfaces of windows has been placed on the market by the Carbozite Corporation, First National Bank Bldg., Pittsburgh, Pa. The compound is known as "Carbozite Blackout Black." It adheres firmly to glass, is impermeable to moisture, and is unaffected by acid fumes, alkalies, smoke, soot, extreme heat or cold, or sunlight. It can be readily applied by brushing or spraying, and is removed with gasoline, kerosene, or any light petroleum solvent.....210

To obtain additional information about materials described on this page, see lower part of page 234.

NEW TRADE LITERATURE

RECENT PUBLICATIONS ON MACHINE SHOP EQUIPMENT, UNIT PARTS, AND MATERIALS

To Obtain Copies, Fill in on Form at Bottom of Page 233 the Identifying Number at End of Descriptive Paragraph, or Write Directly to Manufacturer, Mentioning Catalogue Described in the July Number of MACHINERY

Socket-Screw Dimension Finder

PARKER-KALON CORPORATION, 202 Varick St., New York City, is distributing to engineers, designers, and production men, a socket-screw dimension finder, giving all important dimensions of the standard sizes of socket-head cap-screws, stripper bolts, and set-screws. Requests for this device must be made on a company letter-head, mentioning the writer's title and the make of socket screw used. 1

Lubricating Systems

TRABON ENGINEERING CORPORATION, 1814 E. 40th St., Cleveland, Ohio. Bulletin 423, on reversing lubricating systems, describing the Trabon single-pipe centralized system that lubricates all the connected bearings without using springs, diaphragms, packing, or exposed moving parts. 2

Oilless Bearings

NEVEROIL BEARING CO., Wakefield, Mass. Catalogue 11, containing data on oilless and self-lubricating bearings known as "Graphex," "Coprex," and "Woodex." Special attention is called to the latter — a wood impregnated bearing. 3

Safety Equipment

A. SCHRADER'S SON, 470 Vanderbilt Ave., Brooklyn, N. Y. Folder entitled "Safety Simply a Matter of Horse Sense — and Thoughtful Observation around the Plant." Pneumatic safety installations are illustrated and described. 4

Pipe Threading

REPUBLIC STEEL CORPORATION, Cleveland, Ohio. Folder entitled "How to Get Better Threading Results on Pipe," including notes on grinding dies, diagram of chaser cutting angles, cutting speeds, and threading die terms. 5

Lubricants and Cutting Oils

SUN OIL CO., 1608 Walnut St., Philadelphia, Pa. Bulletin entitled "Helping Industry Help America," giving actual case histories of how the proper use of petroleum products, lubricants, processing oils, cutting oils, etc., has increased production. 6

Salt Baths for Heat-Treating

E. F. HOUGHTON & CO., 303 W. Lehigh Ave., Philadelphia, Pa. Catalogue on Houghton's liquid salt baths for carburizing, annealing, reheating, tempering, and neutral hardening, including a detailed description of Perliton liquid carburizer. 7

Cleaning Methods

OAKITE PRODUCTS, INC., 26 Thames St., New York City. Treatise entitled "Cleaning Gun Barrels after Proof Firing," describing an improved method, which saves time and eliminates the need of oiling the barrels. 8

Heat-Treating Equipment

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia, Pa. Publication entitled "Modern Precision," containing news of L & N instruments, controls, and heat-treating methods, and of the jobs they are doing in industry. 9

Shell Gages

FEDERAL PRODUCTS CORPORATION, 1144 Eddy St., Providence, R. I. Catalogue descriptive of dial indicator inspection gages designed to inspect shells, bombs, small-arms ammunition, and similar ordnance material. 10

Internal Grinders and Oil-Groovers

WICACO MACHINE CORPORATION, Stenton Ave. and Louden St., Wayne Junction, Philadelphia, Pa. Catalogue descriptive of Wicaco precision internal grinders, heavy-duty horizontal oil-groovers, and continuous oil-groovers. 11

Pneumatic Cylinders

HANNIFIN MFG. CO., 621-631 S. Kolmar Ave., Chicago, Ill. Bulletin 57, descriptive of Hannifin Series R, leakproof design, double-acting pneumatic cylinders, and Series LW pneumatic cylinders with cup type pistons. 12

Machining Nickel and Nickel Alloys

INTERNATIONAL NICKEL CO., INC., 67 Wall St., New York City. Bulletin T-12, revised as of April, 1942, covering the machining of Monel, K Monel, R Monel, KR Monel, Inconel, and nickel. 13

Care of Rubber Belts

MANHATTAN RUBBER MFG. DIVISION OF RAYBESTOS-MANHATTAN, INC., Passaic, N. J. Wall card giving complete instructions for the proper installation and care of rubber transmission belts, V-belts, and conveyor belts. 14

Spray Painting Equipment

BINKS MFG. CO., 3114-40 Carroll Ave., Chicago, Ill. Catalogue 80,

covering the Binks complete industrial spray painting and finishing systems. Copies will be sent to those requesting them on a company letter-head. 15

Bomb Extinguishing Compound

O. H. ADAMS CO., 2018 E. Thomas Ave., Milwaukee, Wis. Circular entitled "First Thought in Case of an Air Raid," containing information on an incendiary-bomb extinguishing compound known as "Bomb-Quench." 16

Cutting-Off Machines

DEWALT PRODUCTS CORPORATION, Lancaster, Pa. Folder on the DeWalt high-speed metal cutting-off machine with a capacity of 1 1/2 inches for solid ferrous and nonferrous metals, and up to 4 inches for tubing. 17

Brass, Bronze and Iron Alloys

CRAMP BRASS & IRON FOUNDRIES, DIVISION OF THE BALDWIN LOCOMOTIVE WORKS, Paschall P. O., Philadelphia, Pa. Reference catalogue for engineering purposes on Cramp brass, bronze, and iron alloys. 18

Rotary Surface Grinders

PORTMAN MACHINE TOOL CO., 17-19 Beechwood Ave., Mount Vernon, N. Y. Bulletin PG12, illustrating and describing the Portman No. 12 vertical rotary surface grinder. 19

Electric Motors

GENERAL ELECTRIC CO., Schenectady, N. Y. General catalogue GEA-623E for 1942, covering applications, ratings, prices, and engineering data relating to the G-E line of electric motors. 20

Shakeproof Fasteners

SHAKEPROOF INC., 2501 N. Keeler Ave., Chicago, Ill. Catalogue AD-1, containing engineering and procurement data on Shakeproof cowl fasteners, developed to meet the needs of the aircraft industry. 21

Ball Bearings

NEW DEPARTURE DIVISION GENERAL MOTORS CORPORATION, Bristol, Conn. Booklet "New Departure Engineering Service, Part Two—Details of Design of Shafts and Housings for Ball Bearings." 22

High-Speed Machine Tools

DURO MFG. CO., 800 E. 61st St., Los Angeles, Calif. Bulletin descriptive of Duro machine tools for high-speed production, including inclinable punch presses and multi-purpose bench millers. 23

Machine Tool Live Centers

STURDIMATIC TOOL CO., 5220 Third Ave., Detroit, Mich. Bulletin illustrating and describing the Sturdimatic heavy-duty live centers for lathes, grinders, milling machines, screw machines, etc. 24

Electric Motors

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa. Leaflet L-20653, illustrating and describing the Westinghouse HG synchronous motor for coupled, belted, and geared service. 25

Welding Equipment

LINCOLN ELECTRIC CO., Cleveland, Ohio. Machine Design Application Sheet No. 81, descriptive of the redesigning of a press bed for welding. 26

Hydraulic Presses

A. B. FARQUHAR CO., LTD., 175 Duke St., York, Pa. Bulletin 42-S-HP, describing a representative group of hydraulic presses for war production purposes. 27

Boring Machines

B. M. ROOT CO., York, Pa. Catalogue 120, on electro-hydraulic boring machines especially developed for use on wood, composition materials, plastics, and light metals. 28

Roller Bearings

BOWER ROLLER BEARING CO., 3040 Hart Ave., Detroit, Mich. Folder entitled "Where Bower Design Provides Positive Roll-End Lubrication." 29

Conserving Rubber

UNITED STATES RUBBER CO., Rockefeller Center, New York City.

To Obtain Copies of New Trade Literature

listed on pages 232-234 (without charge or obligation), fill in below the publications wanted, using the identifying number at the end of each descriptive paragraph; detach and mail to:

MACHINERY, 148 Lafayette St., New York, N. Y.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Name ..... *Position or Title* .....

[This service is for those in charge of shop and engineering work in manufacturing plants.]

Firm .....

Business Address .....

City ..... *State* .....

[SEE OTHER SIDE]

Forty-eight page book entitled "First Aid to Industry in Conserving Rubber." 30

Burring Compound

LEA MFG. CO., Waterbury, Conn. Booklet entitled "Burring with the Lea Method," describing Lea compound, a greaseless buffing composition. 31

Welding Timers

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa. Booklet B-3079, illustrating and describing Westinghouse sequence and automatic weld timers which increase weld production. 32

Small Precision Ball Bearings

MINIATURE PRECISION BEARINGS, Keene, N. H. Circular on three new additions to the company's line of non-magnetic radial and pivot bearings. 33

Spot-Welding Machines

PIER EQUIPMENT MFG. CO., Benton Harbor, Mich. Catalogue 41, illustrating and describing Ace foot-operated and motor-driven automatic spot-welders. 34

Chucks

UNION MFG. CO., New Britain, Conn. Catalogue 61, illustrating and describing the complete line of chucks for all purposes made by this company. 35

Abrasives

NORTON CO., Worcester, Mass. Folder entitled "Boost Production on Your O. D. Grinding Jobs, Centerless and Cylindrical." 36

Thread Milling Machines

WALTHAM MACHINE WORKS, Newton St., Waltham, Mass. Bulletin illustrating and describing Waltham thread milling machines. 37

Care of Electric Motors

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis. Handbook entitled "A Guide to Wartime Care of Electric Motors." 38

Surface Grinders

HILL ACME CO., 6400 Breakwater Ave., Cleveland, Ohio. Circular entitled "Here is What the Hill Surface Grinder Can Do for You." 39

Foundry Equipment

AMERICAN FOUNDRY EQUIPMENT CO., 555 S. Byrkit St., Mishawaka, Ind. Twelve-page catalogue covering the entire line of products manufactured by the company. 40

Wire Annealing Baskets

CAMBRIDGE WIRE CLOTH CO., Cambridge, Md. Bulletin 77, on wire baskets and crates for use in annealing, pickling, and washing cartridge cases. 41

Tin Bronze

AMPCO METAL, INC., Milwaukee, Wis. Engineering Data Sheet 101 entitled "Alternate Specifications for Tin Bronze." 42

Lock-Nuts

AN - COR - LOX DIVISION, LAMINATED SHIM CO., INC., 86 Union St., Glenbrook, Conn. Folder on An-cor-lox lock-nuts. 43

Lighting Equipment

FOSTORIA PRESSED STEEL CORPORATION, Fostoria, Ohio. Circular entitled "Good Lighting — A Production Weapon." 44

Pickling of Iron and Steel

ENTHONE CO., 442 Elm St., New Haven, Conn. Booklet entitled "Modern Pickling of Iron and Steel." 45

Specifications for Metal Finishes

MAAS & WALDSTEIN CO., Newark, N. J. Booklet "U. S. Government Specification Finishes." 46

Safety Clutches

W. E. HIMES, 411 N. 7th St., St. Louis, Mo. Folder describing Flaton automatic safety clutches. 47

Power Jacks

DUFF-NORTON MFG. CO., 2709 Preble Ave., Pittsburgh, Pa. Circular on rotary air motor jacks. 48

To Obtain Additional Information on Shop Equipment

Which of the new or improved equipment described on pages 235-259 is likely to prove advantageous in your shop? To obtain additional information or catalogues about such equipment, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning machine as described in July, 1942, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Fill in your name and address on other side of this blank.

To Obtain Additional Information on Materials of Industry

To obtain additional information about any of the materials described on pages 230-231, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning name of material as described in July, 1942, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.

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Detach and mail to MACHINERY, 148 Lafayette St., New York, N. Y.

[SEE OTHER SIDE]

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material-Handling Appliances Recently Placed on the Market

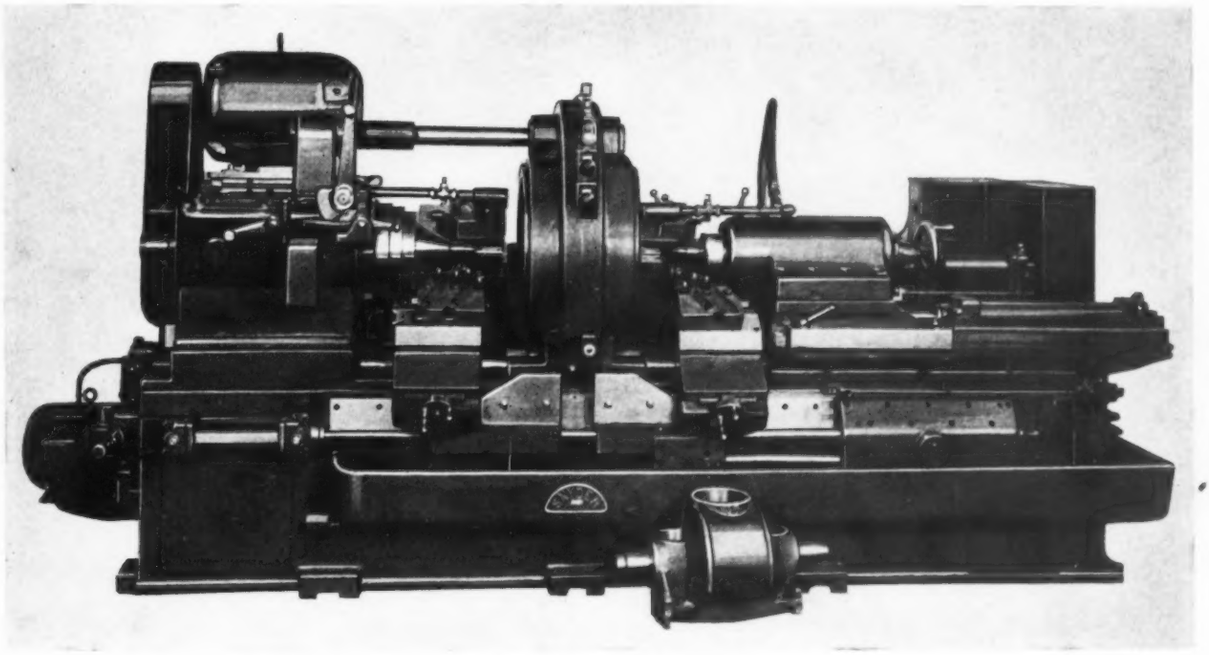
Snyder Heavy-Duty Hydraulic Turning Machine

A heavy-duty, double-end, hydraulic turning machine with center drive has been built by the Snyder Tool & Engineering Co., 3400 E. Lafayette Ave., Detroit, Mich., for machining work of the type shown near the base of the machine in the illustration. This machine is equipped to take two heavy cuts, both the front and rear tool-blocks being manually adjusted between the first and second cuts.

The feed is operated from a single hydraulic unit in the rear of the machine, which furnishes power to both the front and rear tool-slides, as well as to the tailstock. The movement of the tailstock is controlled by a hand-operated valve. This movement is used to facilitate loading and unloading of the work, being employed to push the work forward into the center-drive fixture. The right-hand tool bracket, when swung into the clearance position, provides a loading platform in line with the locating surface in the center drive. When the part has been loaded and pushed into place between centers, it is clamped manually and the tailstock is locked in place, ready for the first two turning operations.

The hydraulic system actuates the front and rear tool-slides, a single cylinder operating cams that move the two front slides into position, at which point the cams stop moving and the tool-slides are traversed through their work cycles. Each front tool-slide has its own hydraulic cylinder, and the slides are connected by a rack to permit the use of a single hydraulic and electrical control. The rear tool-slides are also kept in synchronism by a pair of hydraulically actuated cam-plates which move the slides through a rapid advance and feed cycle.

The control for the entire machine consists of a start and stop push-button, a cycle start push-button, and an emergency return—these being mounted on the center drive in front of the operator. The machine is equipped throughout with anti-friction bearings, the headstock, which has a twin-plate friction clutch between the motor drive and the spindle, being provided with an oil-pump for pressure lubrication. The center drive is carried on a pair of extra large Timken bearings, and is equipped with an oil reservoir from which the oil is carried to the bearings and gears by means of the main gear in the drive.



Snyder Double-end Hydraulic Turning Machine with Center Drive

To obtain additional information on equipment described on this page, see lower part of page 234.

The machine base is of welded steel construction, and serves as a large chip trough and coolant container, the chips being removed from the rear of the machine. The coolant is circulated by a motorized pump. Fine chips in the coolant are removed by thorough screening and by passing the liquid over a series of baffles. 51

H P M All-Hydraulic Fastraverse Forging Press

An all-hydraulic Fastraverse press for forging hot billets has been developed by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio. This press is entirely self-contained, and requires no auxiliary equipment, such as a steam boiler, intensifier, accumulator, pipes, valves, and other equipment necessary for the operation of the earlier steam-hydraulic type presses. Basically, the design of the press proper is the same for both types of presses, with the exception that a number of new features have been incorporated in the self-contained press that has just been brought out.

All pressure and working parts of the new press are lubricated by the operating medium, which is a clean, cool lubricating oil. As this oil is continuously filtered and cooled, there is no chance for it to become loaded with dirt and abrasives, or to lose its lubricating quality. The press is started, stopped, reversed, and its speed is changed by varying the pump stroke, control valves being entirely eliminated.

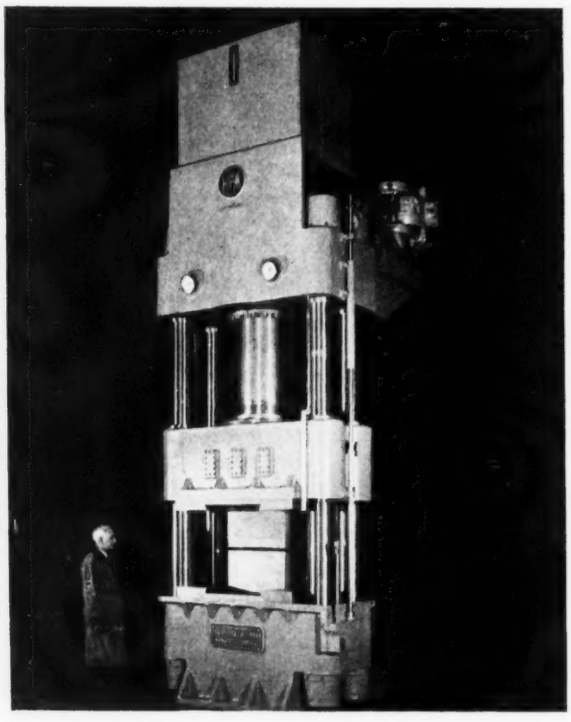
Important advantages of the all-hydraulic press include the closed-circuit system, the H P M surge valve, the Hydro-Power radial, variable-delivery, oil pressure pump with precision tapered bearings, and provision for external adjustment to take up wear without dismantling the pump or its connections. Other advantages are control of entire press operation by one hand-lever, rapid closing of press by gravity, and maintenance of press cylinder full of oil during the closing movement by the surge valve, which permits high-speed closing. The pressure stroke thus follows up automatically with no appreciable time lag, because the cylinder is already filled with oil. This feature permits rapid control of the press for planishing operations. 52

Wickman Form Grinder

A machine known as the "Optical Form Grinder," in which a number of new features have been incorporated, has just been introduced to the trade by the Wickman Corporation, 15533 Woodrow Wilson Ave., Detroit, Mich. This machine is manufactured for the Wickman Corporation by the Sheffield Corporation, Dayton, Ohio. It is designed for accurate finish-grinding of flat or circular form tools, punches and dies, profile gages, templets, etc., and is particularly adapted for grinding parts made of tungsten carbide and hard tool steels.

Actually, the machine is a combination of a full universal tool grinder with a pantograph-controlled optical checking instrument. The grinding head carries a wheel-slide which moves up and down at 80 strokes a minute across the contour of the part to be ground. The work is clamped to the table, and its position controlled and set by compound slides.

Preliminary to the grinding operation, a lay-out enlarged to a 50 to 1 ratio is prepared in the drafting-room on any paper that will retain its size and form. This lay-out is fastened to the lay-out table



H P M Hydraulic Forging Press

Wickman Optical Form Grinder

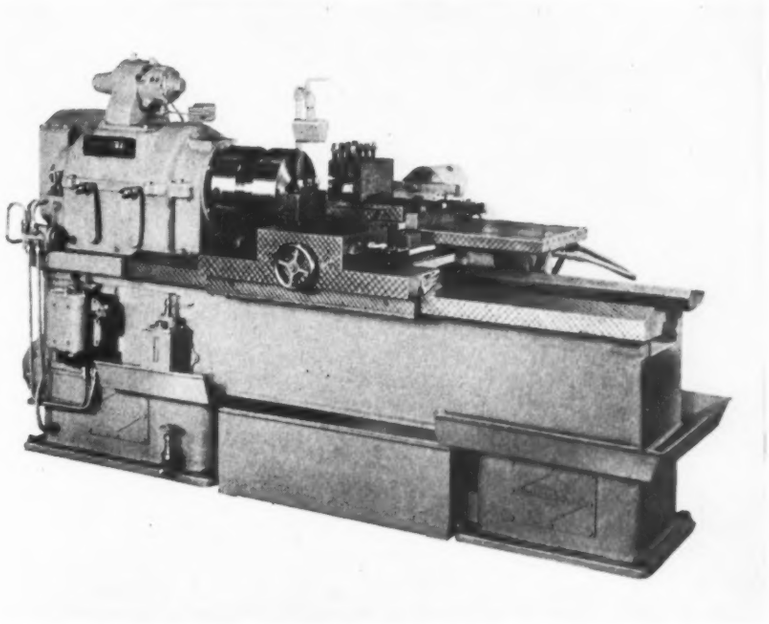
To obtain additional information on equipment described on this page, see lower part of page 234.

located above the machine. The lay-out table is adjustable, and can be locked in position. There is a 50 to 1 ratio pantograph for use in conjunction with the lay-out table. A 30-power microscope is carried on the short arm, while the long arm of the pantograph carries a pointer which the operator moves from point to point along the line of the lay-out. The microscope is arranged with rotating cross-hairs, the intersection of which corresponds to the position of the pointer on the long pantograph arm. As the operator moves the pantograph pointer, the intersection of the cross-hairs moves correspondingly at the 50 to 1 reduction ratio.

The wheel-head assembly can be adjusted to any desired position or angle by three radial slides, and its path across the contour of the work is manually determined by lateral and longitudinal cross-slides. The grinding wheel is fed to the point established by the intersection of the cross-hairs, and its exact position is observed through the microscope. As the work is being inspected directly in the operating plane, the wheel is fed up to the determined point on the work. Thus, the accuracy of the grinding operation is not affected by wheel wear.

The 2-inch stroke of the wheel permits a number of thin pieces to be stacked together. This feature is particularly useful when producing small quantities of precision parts which must be identical. The machine will grind a form 5 3/4 inches long and 2 3/8 inches deep in parts 2 inches thick. The lay-out size is 20 inches square, which makes it possible to grind an area of 0.400 by 0.400 inch in one setting. Profiles greater than 0.400 inch square can be handled by special methods.

By the use of the same equipment, but reversing the procedure, it is possible to inspect the part without taking it out of the machine. It is also possible to record or transfer the contours of a part on a drawing fifty times its size. A separate motor-driven circular grinding attachment is available for use on cylindrical work, such as circular form tools, for which the reciprocating motion of the wheel is not used. The entire machine, including the lay-out table, occupies a floor space 61 1/4 by 45 1/4 inches. ---------- 53



Norwood Automatic Shell-turning Lathe Equipped for Cutting-off, Base-finishing, and Band-grooving Operations

Norwood Hydraulically Operated Automatic Shell-Turning Lathe

Approved for Publication by the War Department

The hydraulically operated automatic lathe manufactured by the Norwood Engineering Co., Florence, Mass., is being built in four models for performing various machining operations on 50- to 155-millimeter shells. Important units of this lathe, such as the headstock, drive, base, hydraulic equipment and oiling system, have been standardized and designed for production machining, each model, however, being equipped and tooled for a specific purpose.

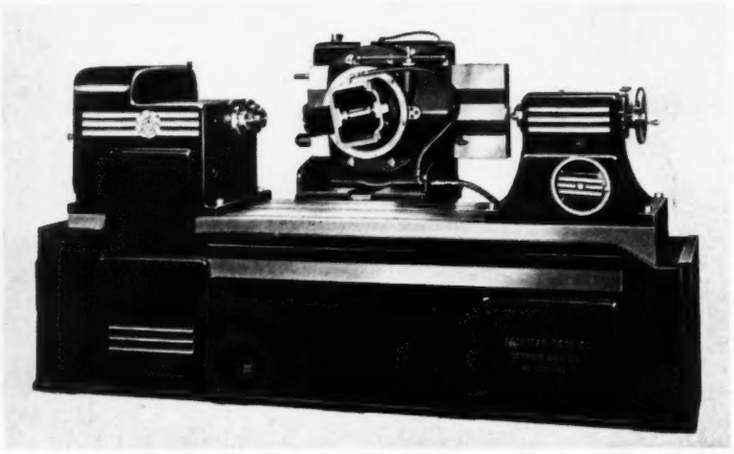
All movements are performed hydraulically and automatically, production at the maximum rate being easily accomplished by two simple operations, both controlled by levers or push-buttons. The first control serves to chuck the work at the start of the operation and release it at the end. The second control starts the automatic cycle of the machining operation. The tools are automatically traversed to the work, slowed down to cutting speed, fed through their respective cuts, and then rapidly traversed back to their starting positions. The front and back tools work independently, but in fixed relation to each other to complete their respective cycles.

Some of the important advantages claimed for these machines are maximum production obtained by high rate of cutting feed and fast, easy handling of work; uniform rate of feed at maximum cutting capacity of tool; infinite variation of feed rate; maintenance of constant feed rate when desired; freedom from chatter; easy set-up; and easy operation.

The Model ST-1 machine centers and cuts off the shells. The carriage of this machine is provided with a rest on which a motor and a center drill are rigidly mounted. The Model ST-2 machine is equipped for the rough-turning operation. It has a heavy-duty tailstock and a revolving spindle, with a No. 5 Morse center. In addition to the carriage, which has an exceptionally long bearing on the ways, there is a cross-slide at the front equipped with three tool-holders for roughing tools and a unique arrangement for a boat-tail tool. There is also a back tool-slide with one holder for the back-facing tool.

The Model ST-3 machine bores the nose and rough-faces, rough-reams, finish-reams, and faces the shells. A hexagonal turret with all faces bored and tapped to receive tool-holders is mounted on the carriage. Manual indexing of the

To obtain additional information on equipment described on this page, see lower part of page 234.



Rotary Gear-shaving Machine Brought out by Michigan Tool Co.

turret can be quickly and positively accomplished.

The Model ST-5, shown in the illustration, cuts off and finishes the base of the shell, and cuts the band groove. This model has a carriage located in a fixed position, on which is mounted a cross-slide with one tool-holder, and a rear slide with two tool-holders. 54

Michigan Heavy-Duty Gear-Finishing Machine

A new rotary gear-shaving machine—the 865-36A—which utilizes the crossed-axis principle of gear finishing, has been added to the line of the Michigan Tool Co., Detroit, Mich. This machine will handle gears up to 36 inches in diameter, and is similar in design to the larger 865-48A machine recently placed on the market. It is equipped with two driving spindles for handling large and small gears, and is designed to have the work serve as the driver, while the cutter, engaged with the work, becomes the follower.

Three methods of finishing gears can be employed on the new machine. The first method is particularly well adapted for finishing gears having wide faces, as the cutter, in addition to having an in-feed toward the gear, also has a reciprocating motion parallel to the axis of the gear. Gears up to 20 inches in face width can be finished by this method at any point within 48 inches from the headstock when mounted on shafts up to 72 inches long between centers.

In the second method, used for quick finishing of gears having a narrower face width than the cutter, the slide is set vertically, the cutter, however, being in the same relationship to the gear as in the first method. In the second method, in-feed is not employed, but the cutter-head is located in such a manner that the axis of the cutter, and the axis of the gear, when viewed vertically, are at the proper center distance from each other to obtain the correct depth of cut.

The third method represents a combination of the first and second. The cutter-slide, in this case also, is located in a vertical plane, but in-feed is used. The cutter-head reciprocates vertically instead of horizontally, as in the first method, the gear being finished by a number of vertical "passes" instead of one pass, as in the second method. Any amount of in-feed can be used.

The cycle is automatically terminated in the first and third methods by means of a limit switch. The last two methods are both suitable for gears having a narrower face width than that of the cutter. Gears can also be crowned when these two methods are employed by using crowned cutters. Gears as small as 4 inches in diameter can be handled with cutters down to 8 1/2 inches in diameter. The maximum cutter-face width which can be used is 6 inches, the maximum diameter being 12 inches.

The spindle nearest the cutter handles gears from 4 to 18 inches in diameter, while the spindle farthest from the cutter is employed for gears from 18 to 36 inches in diameter. The center distances between the work-spindles and the cutter-spindle range from 6 1/8 to 16 1/2 inches for small work, and from 16 to 26 inches for large work. 55

Matthews Fuse-Marking Machine

Approved for Publication by the War Department

A No. 201 fuse-marking machine has been designed by Jas. H. Matthews & Co., Pittsburgh, Pa., for use in fuse manufacturing, assembling, and loading plants. This machine is adapted for marking the outside surfaces of fuse bodies or parts of practically all sizes and models with a stamped impression. Fuse bodies, parts, or round pieces to be marked are fed by hand from the right-hand side of the machine up to the continuously rotating pressure dial table.

The parts are carried around between this table and the die-holder. The part being marked rotates under pressure against the dial, thus completing the marking. The marked piece is swept off the dial by an ejecting plate when it arrives at the left side of the machine. The pressure dial is machined to match the contour of the piece to be marked. It can be replaced by other dials designed to suit fuses of different shapes and sizes. The machine requires a floor space of 24 by 30 inches. 56

Fuse-marking Machine Made by Jas. H. Matthews & Co.

To obtain additional information on equipment described on this page, see lower part of page 234.

DEPENDABLE EQUIPMENT

to Help Push Production "Over the Top"

Meet today's defense needs with accurate, long-lived Brown & Sharpe Equipment – to get out the work *fast.*

We are proud to be honored with the Navy "E", awarded for outstanding accomplishment in Defense production.
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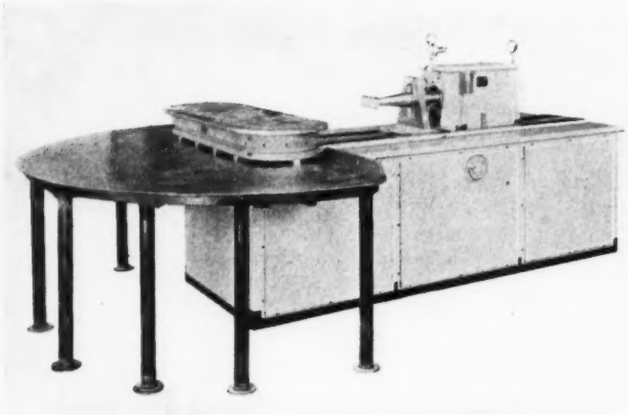


Fig. 1. Machine Built by Southern Engineering Co. for Forming Extruded Metal Sections to Any Desired Shape

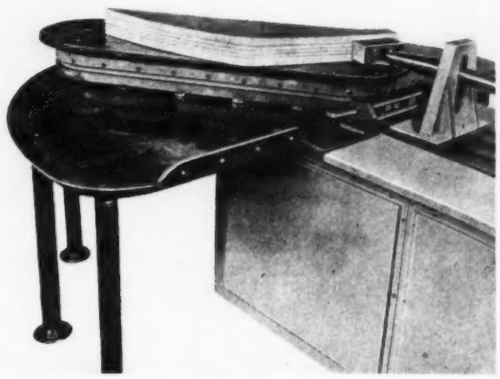


Fig. 2. Die and Pusher-block Used to Form Two Extruded Parts Simultaneously

Machine for Forming Extruded Metal Sections to Various Shapes

A new type machine developed primarily for the economical and rapid forming of extruded sections to various shapes has been brought out by the Southern Engineering Co., Inc., 1001 Architects Bldg., 816 W. 5th St., Los Angeles, Calif. This machine is already in use in several large plants; it is claimed that production has, in some cases, been increased forty-five times over former hand-forming methods.

The machine consists of two basic sections — the movable head on which the dies are bolted, and the air ram to which the mating die is attached. A 5 - H. P., variable-speed, reversible transmission drives the head, through reduction gears and a pinion system, at stepless speeds ranging from 91 to 275 inches per minute. A maximum pressure of 2 1/2 tons can be exerted by the air ram when the machine is operated by normal air-line pressure, such as is available in most plants.

The bending of straight extruded sections to the desired form, which may involve a number of changes in the bending plane, as well as in the profile, is accomplished by attaching one end of the straight section to the movable die and then drawing it between the movable die and the die-block on the air ram. The metal is tightly confined in the cavities of the die, and any type of extruded stock can be formed without danger of wrinkling and with a minimum of internal stresses.

Three types of movable heads are available: A circular one for forming parts that have a symmetrical radii or an interrupted radii with no straight sections; a semicircular head for forming parts with straight sections, slow sweeps, curves, and offsets; and a straight head which travels only in a straight line for forming longitudinal parts that have relatively small sweeps. The first two heads revolve forward, backward, or through a full 360-degree circle.

Such materials as magnesium, Dural, and stainless steel can be formed on the machine, in addition to aluminum alloys. By the use of a mandrel, tubular sections can be formed as easily as conventional extruded sections. It is possible to make open seam tubing, flanged tubing, and Z-shaped sections, in addition to bending tubes. 57

Improved "Index" High-Speed Vertical Milling Machine

An improved "Index" high-speed vertical milling machine has just been placed on the market by the Blank & Buxton Machinery Co., 3100 E. Michigan Ave., Jackson, Mich. The vernier scales on this machine, previously mounted straight up and down, are now tilted at an angle, as shown in Fig. 2, to facilitate quick reading.

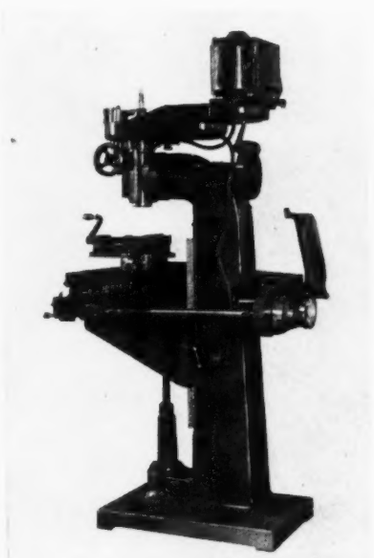
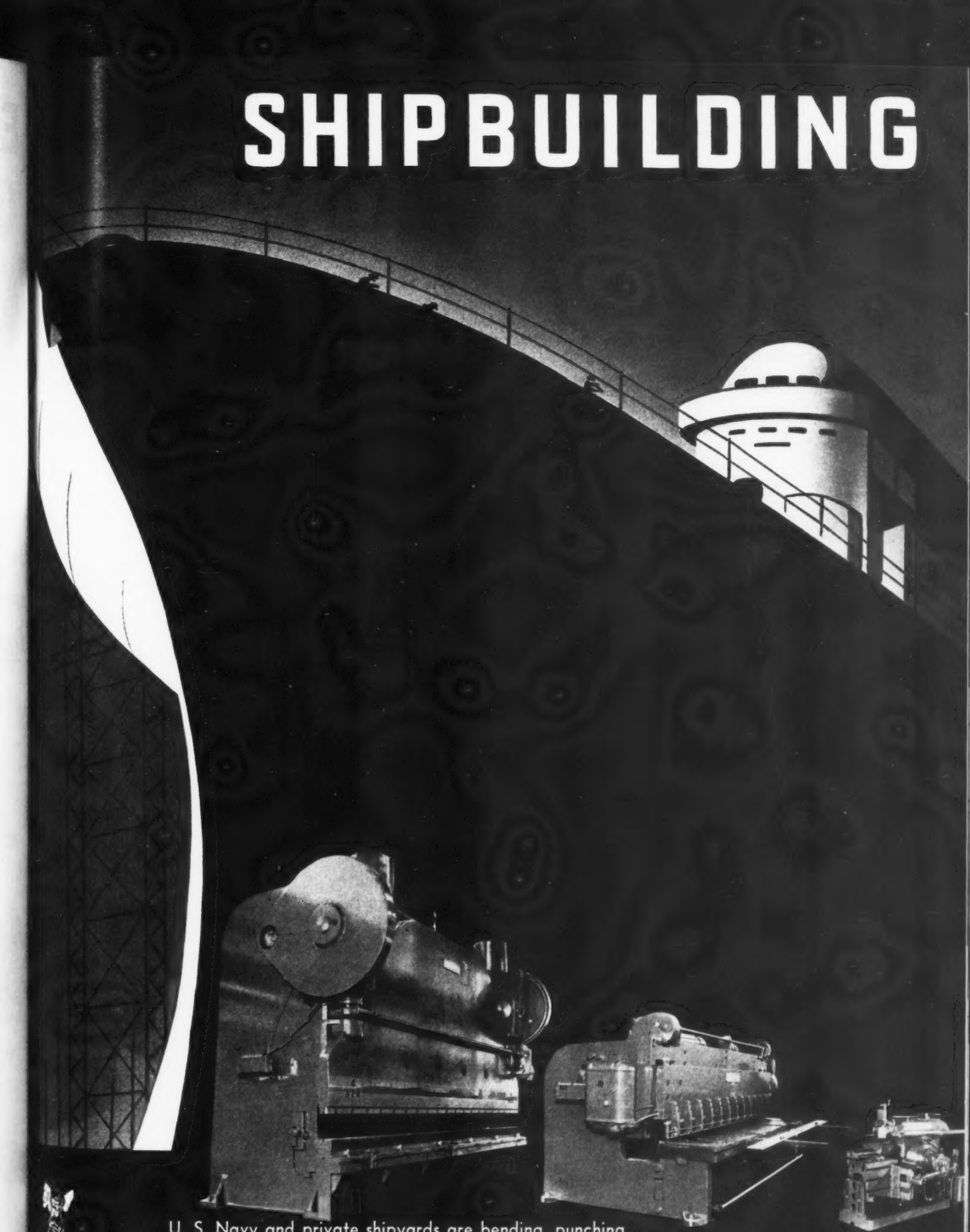


Fig. 1. "Index" High-speed Milling Machine of Improved Design

Fig. 2. Tilted Vernier Scales on "Index" Milling Machine

To obtain additional information on equipment described on this page, see lower part of page 234.

SHIPBUILDING



U. S. Navy and private shipyards are bending, punching, and shearing plate on Cincinnati Press Brakes and Cincinnati Shears. Cincinnati Shapers are working aboard ships as well as in the yards.

Write for Recommendations

THE CINCINNATI SHAPER CO.

SHAPERS · SHEARS · BRAKES

CINCINNATI, OHIO.

Also, the cross-vernier scale has been moved from the front of the knee to the rear where it can be more easily read. These verniers can be used for locating a variety of pieces, such as gages, jigs, fixtures, etc.

Power feed to the spindle is another feature provided on this improved machine to facilitate precision boring operations on jigs and fixtures and intricate small parts. Milling, drilling, and boring can be performed in one setting of the work. Power feed to the table can now be obtained as extra equipment if desired.

The spindle runs in precision preloaded ball bearings, has a No. 9 B & S taper, and will take end-mills up to 5/8 inch for machining operations on tool steel. Larger cutters can, however, be used on many jobs. The quill movement imparted to the spindle is 3 1/4 inches, with power feed optional. The head swivels 90 degrees either way.

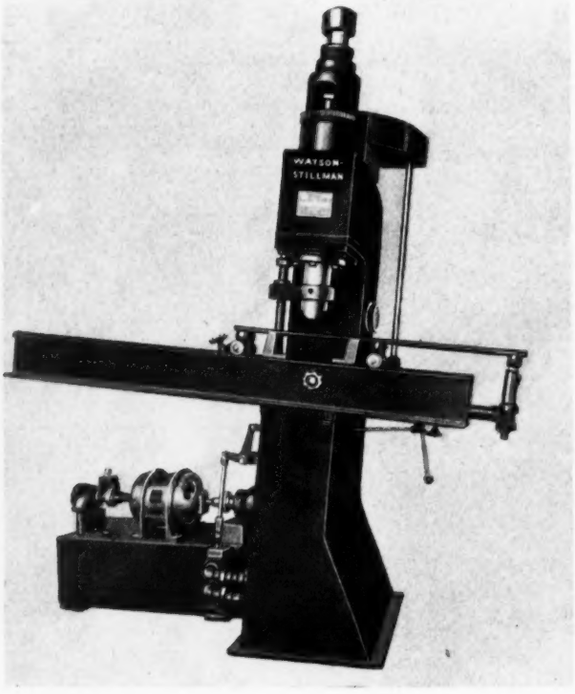
The working surface of the table is 8 by 22 inches, and the over-all length 30 inches. Six standard spindle speeds are available ranging from 180 to 2400 R.P.M., and special provision can be made for obtaining twelve spindle speeds from 120 to 3700 R.P.M. 58

Watson-Stillman Gun-Barrel Straightening Press

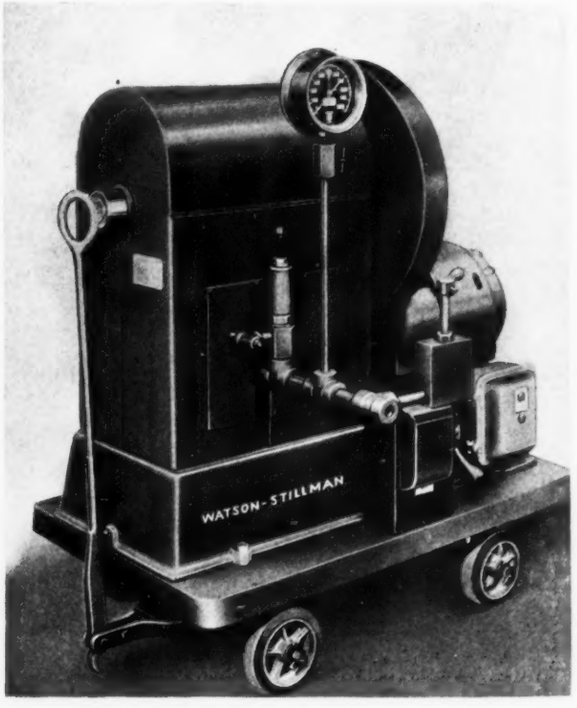
Approved for Publication by the War Department

An improved 50-ton press for finish-straightening gun barrels has been developed by the Watson-Stillman Co., Roselle, N. J. The machine differs from former types in that it has a positive stop adjustment controlled by a hand-wheel, and an angle base, as shown in the illustration, which facilitates sighting along the barrel being straightened.

The press is also suitable for straightening structual members. It has a 12-inch opening, 10-inch gap, and 9-inch stroke. The table is 6 feet long by 11 1/2 inches wide. The ram diameter is 8 inches. The machine is controlled by a single hand-lever. Power is furnished by a 7 1/2-H.P. motor, which drives the press through rotary vane type pumps. The complete unit weighs 7250 pounds, stands 11 feet 6 inches high, and requires a floor space of 6 feet by 3 feet. 59



Gun-barrel Finish-straightening Press Developed by Watson-Stillman Co.



Watson-Stillman Portable Unit for Testing High-pressure Equipment

Watson-Stillman Motor-Driven Portable Test Pump for High-Pressure Equipment

A motor-driven portable test pump for use in testing boilers, tubing, and all kinds of high-pressure vessels has been brought out by the Watson-Stillman Co., Roselle, N. J. The entire unit, including the motor, is mounted on a hand truck, and has all parts enclosed for protection against abrasive dust.

The pump is a three-plunger vertical unit driven by a 3-H.P. motor at 100 R.P.M. At this speed, it develops a maximum pressure of 8200 pounds per square inch and delivers 1/2 gallon per minute. The equipment includes a pressure gage, safety valve, needle valve for pressure regulation, motor, motor starter, disconnect switch, and rubber cable. The entire unit is 50 inches long, 30 inches wide, 48 inches high, and weighs 1450 pounds. 60

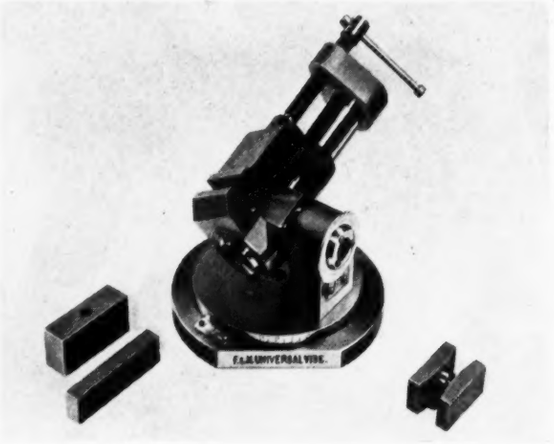
F & H Equipment for Angle-Machining Work

Equipment consisting of an F & H universal vise with improved locking control, a grinding-

To obtain additional information on equipment described on this page, see lower part of page 234.

Industrial
DRILLING
Practices...
SUPER C B SERVICE
AT A
U.S. NAVAL
AIR STATION
CINCINNATI BICKFORD
Here, as in industry, it is necessary to get the most possible work out of the least possible space and power.
The versatility of this 3' arm, 9" dia. column machine is due to its special base, with box and universal tables. Drilling, reaming and tapping of large pieces are facilitated on the base, small pieces on either of the tables, odd angle operations in small pieces are accomplished with the universal table. Sometimes two operators run one machine; one operator sets up a job on one table while the other operator is processing a job already set up on either the base or the other table.
For further information about your metal drilling problems don't hesitate to get in touch with us.
THE CINCINNATI BICKFORD TOOL CO.
OAKLEY • CINCINNATI • OHIO • U. S. A.

wheel angle-dressing attachment, and a unique swivel clamp for holding odd-shaped pieces has been placed on the market by the F&H Mfg. Co., 6024 Ellery St., Detroit, Mich. This tool equipment, referred to as an "Angle-Machining Package," is especially designed to reduce set-up time in handling work involving the machining of surfaces to compound angles. The swivel clamp, consisting of two friction plates joined by a ball and socket, fits between the work and one jaw of the vise, being fastened to the latter and adapting itself to the angle of the work.



F & H Angle-machining Equipment

The universal vise is of all-steel construction, and is precision-built, with hardened and ground steel jaws. Vernier dials are used to obtain precision in machining work to any angle in the vertical or horizontal planes. The vise is compact and easily portable, being only 4 3/4 inches high and weighing about 14 pounds. The jaws open to a width of 2 1/4 inches.

The grinding-wheel dressing attachment fits into the universal vise, eliminating the need for a separate angle-wheel dresser. The dressing tool is rigidly held at the correct "drag" angle for wheel-dressing. 61

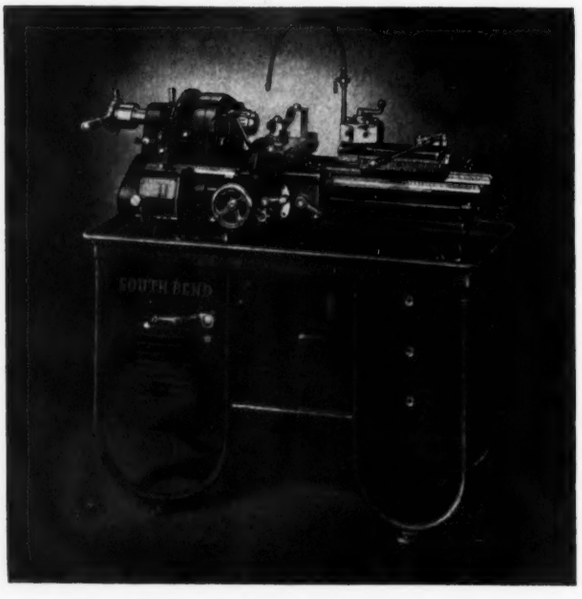
South Bend Turret Lathe

A new bench model turret lathe, designed for rapid production to close tolerances on chucking operations or bar work, has been added to the line of the South Bend Lathe Works, Department M2, South Bend, Ind. This lathe has a 10-inch swing over the bed and saddle wings, a 1 3/8-inch hole through the headstock spindle, and a 1-inch collet capacity. It is especially adapted for second-operation work.

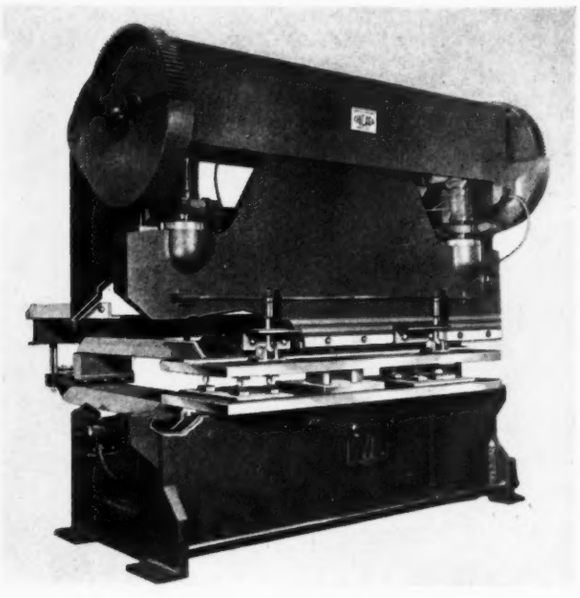
The hand-lever operated bed turret indexes automatically, and has an adjustable stop for each of the six turret faces. The lathe is equipped with both a compound-rest cross-slide and a hand-lever operated cross-slide, which are interchangeable. The latter is furnished with front and rear tool-blocks which provide three tool positions. A quick-change gear-box supplies forty-eight longitudinal power feeds for the universal carriage, forty-eight power cross-feeds for the compound-rest cross-slide, and forty-eight thread-cutting feeds ranging from 4 to 224 threads per inch. The underneath motor drive and back-gears give twelve spindle speeds ranging from 97 to 700 R.P.M. A large assortment of attachments and accessories is available for special work or second-operation jobs. 62

Leslie Die Sets for Press Brakes

A self-balancing universal die set designed to insure positive alignment of the punch and die members, which can be supplied for use on press brakes of all sizes, has been developed by the Leslie Welding Co., 2943 W. Carroll Ave., Chicago, Ill. This die set is designed to greatly expand the range



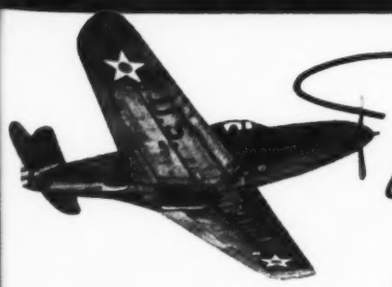
South Bend Lathe for Second-operation Work



Press Brake Equipped with Leslie Balanced Die Set

To obtain additional information on equipment described on this page, see lower part of page 234.

WHERE *Precision* IS PRICELESS



YES, it's a comparatively small part —*a cylinder hold down stud*—only one of many threaded hardened pieces that go to make up the powerful engines of today's fighting planes . . . small but vital parts that must be *precision-machined* if they are to endure the stress that's unavoidable in modern airplane engines . . . this stud (with threads on both ends, tapered and straight, *precision ground* from the solid after heat treat) is typical of thousands of hardened parts being threaded on a production basis day and night for the aircraft industry . . . *on Ex-Cell-O thread grinding machines* . . . to the highest commercial standards of accuracy in size and finish.

EX-CELL-O CORPORATION • DETROIT, MICH.

The modern precision thread grinder is an Ex-Cell-O accomplishment, introduced by Ex-Cell-O to American industry in 1935. There are nine styles of Ex-Cell-O Precision Thread Grinding Machines, covering an extremely wide range of work for both external and internal threads. Below is Ex-Cell-O Style 33 Automatic (used for production of precision threaded hardened stud shown above)

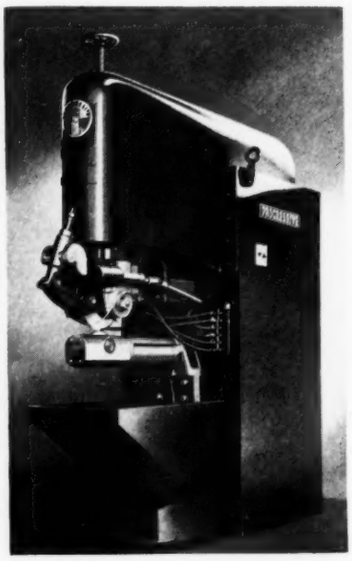
XLO

EX-CELL-O *means* PRECISION

Precision THREAD GRINDING, BORING AND LAPPING MACHINES, TOOL GRINDERS, HYDRAULIC POWER UNITS, GRINDING SPINDLES, BROACHES, CUTTING TOOLS, DRILL JIG BUSHINGS, PARTS

of punching operations that can be performed on press brakes. It makes it possible to perform economically many stamping and blanking operations on large-sized plates that previously required the use of extremly large straight-sided presses. This equipment not only permits work of unusual length and width to be handled, but it also provides for accurate die alignment without cumbersome and expensive leader-pin die sets.

The die set is mounted in the press brake. Individual punch and die assemblies can be removed for repairs or changed without disturbing the rest of the set-up. With this arrangement, new dies can be assembled on the press. 63



Medium-duty Seam-welder

Seam-Welders Built in Three Capacity Ranges

A complete line of seam-welders in three capacity ranges and 126 models is now being built by the Progressive Welder Co., 3050 E. Outer Drive, Detroit, Mich. The light-, medium-, and heavy-duty series are available with several standard throat depths, and each type can be had with any of six standard drives, three for circular- and three for straight-seam welding. The universal model, which can be used for both straight and circular welding, is also available in three different drive types and in each capacity range. They can be used for either interrupted or continuous seam-welding. 64

Plan-O-Mill with Thy-mo-trol

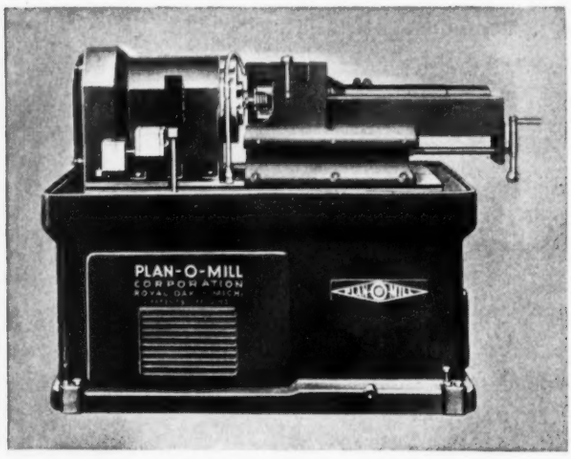
An important improvement in the Plan-O-Mill planetary milling machine previously described in MACHINERY has been announced by the Plan-O-Mill Corporation, Royal Oak, Mich., (formerly the Gordon-R Co.). The improvement involves the use of a Thy-mo-trol feed control. This control, a new development of the General Electric Co., is built into the Model 3 machine here illustrated. By converting alternating into direct current, the Thy-mo-trol provides a stepless range of cutter feeds, both for the in-feed and rotation around the work, by regulating the flow of current to the feed motor. With this arrangement, the changing of gears and sheaves is unnecessary.

This new equipment is designed to give maximum production consistent with maximum cutter life. Parts too cumbersome or irregular in shape for the usual type milling machine can be milled rapidly and accurately on the Plan-O-Mill, since all motion is confined to the cutter-head, the work remaining stationary. The machine shown in the illustration is designed for internal and external right- or left-hand thread- and form-milling. 65

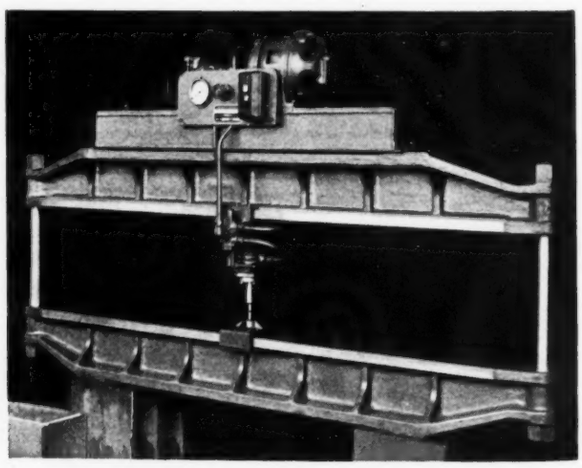
Lake Erie Wide-Clearance Hydraulic Riveting Machine

A 10-ton hydraulic riveting machine having a clearance of 9 feet 10 inches between the tie-rods has been developed by the Lake Erie Engineering Corporation, Buffalo, N. Y., for handling large work. The entire machine is self-contained with a pumping unit and surge tank mounted at the top. The upper and lower cross-members are made of webbed I-beam construction to insure rigidity.

The riveter is mounted on the upper cross-member, and the anvil on the lower member. A manually operated valve controls the downward riveting pressure and the return stroke. The distance between beams is 21 1/2 inches. The machine has a stroke of 3 inches, a ram diameter of 5 inches, and an over-all length of 10 feet 6 inches. The distance from the floor to top of tie-rods is 4 feet 1/2 inch. 66



Plan-O-Mill of Improved Design with Thy-mo-trol Feed Control



Lake Erie Hydraulic Riveting Machine Designed to Handle Large Work

To obtain additional information on equipment described on this page, see lower part of page 234.

AFTER THE WAR—NO DEPRESSION

We look down the road and plan for the dawn of that better day when peacetime needs will once more be the first line activity of American industry and labor. It is evident that the enormous capacity of our new plants and modern equipment will permit America, for the first time, to make enough of all kinds of goods to go around to *all* our people.

Post-war costs can be very low because these new factories will be "charged off" by the time the war is over. Furthermore, craftsmanship is on the increase and working with the hand is no longer looked down upon. A vast reservoir of new and improved products will be ready to flow to every corner of the land if the profit motive and the American enterprise system prevail. We cannot tolerate another prolonged depression, interference with business or an economy of scarcity.

There are two schools of thought that are advocating methods of continuously spreading our production among our people. Under one plan, certain academic thinkers would limit production, would subsidize the incompetent plant, the national debt would continue to mount and the profit motive would be stifled. Our capitalistic system and democratic processes could not long endure under such a plan.

Another school of thought favors unrestricted free enterprise, elimination of monopolies, corrections of restraints caused by patents, cessation of uneconomic deterrence by unions, a tax program that would encourage new enterprise and a free competitive productive economy.

Business management is putting its house in order for post-war productivity that will be possible if the "doers" and not the politicians predominate in planning.

* * *

For peace adaptability, the new process known as Contour Sawing is ideal. Without a single change, each DoAll can be put to work catching up on the vast array of civilian goods that will be in demand as soon as the last shot is fired.

DoAll

WINS THE BATTLE OF PRODUC

DoAll saved 18 hours on this job. Production cut-off of angle irons. Former method, torch and grind-off burr.

- Out of the great American caldron they come in ever-increasing quantities—tanks, planes, jeeps, helmets, guns, bullets.

Behind the allied fighting forces stretch miles of production lines, thousands of modern machine tools, millions of workers on the job 24 hours a day.

Wherever you go you'll find DoAll, the lightweight machine tool that saws through any metal or alloy—steel blocks a foot thick, bars, flats, sheets, tubing, etc. Occupies small space—can be shoved into the regular work line to relieve heavy millers and higher priced shapers of overload work. Cuts out special parts and tools without dies. Saws 70 to 80 shapes at one time from stacked sheets.

DoAll is the fastest precision method to remove metal. Does a week's work in a day—a day's work in an hour—an hour's work in 15 minutes.

Flexing Bars for Dynamometers. Production cutting from 1" Swedish steel.

Cutting openings in 12 gauge 48" steel tank covers.

IN WAR OR PEACE

DoAll can save you valuable time and money. Let a factory-trained man come to your plant and, in a few minutes, show you many ways in which DoAll can increase your production.

NEW BOOK—Case histories of DoAll performance. Photographically told, with short sentences, for busy executives. Send for copy.

CONTINENTAL MACHINES, Inc.

1312 S. WASHINGTON AVE.,
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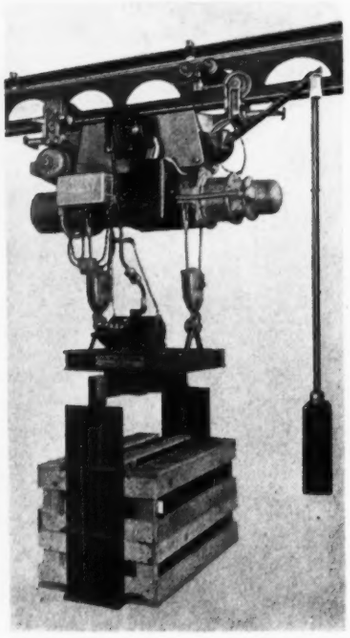
Associated with the DoAll Company, Des Plaines, Ill., Manufacturers of Band Saws and Band Files for DoAll Contour Machines.



Cleveland Motor-driven Crate Grab and Carrier

Motor-Driven Grab and Carrier for Handling Crates

One of the latest developments of the Cleveland Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio, is a motor-driven crate grab and carrier designed especially for moving crates and boxes in and out of storage, or from one elevation to another. The unit is designed to permit quick stacking or removal of crates at unusual heights with safety.

The grab and carrier are completely motorized, with all operations conveniently controlled by the six buttons of the push-button station. If desired, this type unit can be provided with an operator's cab, in which all controls are located. A quick-acting electric brake stops the load at the desired point. The equipment will lift loads up to 1500 pounds a distance of 20 feet. The arms can be spread to a maximum of 36 inches, and retracted to a minimum of 18 inches. 67

Waltham Motorized Thread Miller

The Waltham Machine Works, Newton St., Waltham, Mass., has recently brought out a redesigned model of the thread miller previously manufactured by this company. The improved machine is completely motorized, three motors being used to permit individual speed changing and reversing of both cutter and work, and to provide a constant speed for the pump.

This machine is especially suited for the accurate threading of small work. It has a swing over the carriage of 3 inches, and is best adapted for work up to 2 inches in diameter. The length of thread that can be cut with the work held on centers is 8 3/4 inches. A thread 10 inches long, however, can be cut when one end of the work is held in a spring chuck. The diameter of the hole through the spring chuck is 5/8 inch, and the diameter of the hole through the work-spindle 3/4 inch. The minimum distance between centers is 12 inches. The cutter is 1 11/16 inches in diameter and 0.20 inch thick.

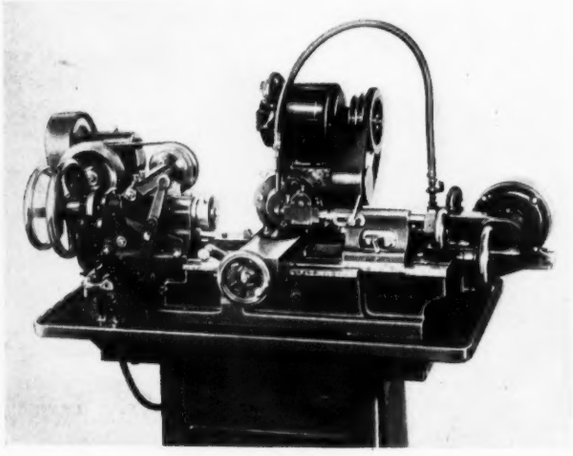
Standard equipment includes motors of 1/3, 1/4, and 1/6 H.P., with starting and stopping push-buttons; a follow-rest; one milling cutter; indexing device for cutting multiple threads; and change-gears for cutting twenty-seven different pitch threads ranging from 5 to 40 threads per inch. The machine can be arranged with speeds suitable for threading either brass or steel.

Special equipment includes a compensating bar for varying the lead of the thread being cut to allow for changes in hardening; plain taper attachment; compound taper attachment; translating gears that provide for cutting twenty-seven different metric lead threads; metric lead-screw; relieving attachments for taps, hobs, and multiple cutters; internal threading cutterhead that can be swiveled to the required helix angle; and special tailstock for multiple cutter work. The machine occupies a floor space of 48 by 34 inches, and weighs 850 pounds. 68

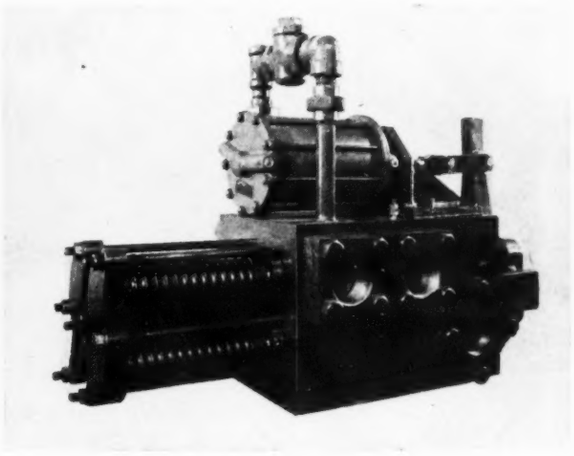
Four-Way Valve for Shell-Forging Presses

Approved for Publication by the War Department

A four-way, quick-acting, operating valve designed especially for shell-forging presses has been developed by the Baldwin Southwark Division of the Baldwin Locomotive Works, Philadelphia, Pa. This



Improved Thread Miller Brought out by Waltham Machine Works



Baldwin Southwark Four-way Valve for Shell-forging Presses

To obtain additional information on equipment described on this page, see lower part of page 234.

HAND FINISHING A ZINC ALLOY DIE
ZINC IN WAR
SPEEDING PLANE PRODUCTION
Sand cast dies of zinc alloy are used for stamping many sheet metal aircraft parts. This procedure saves time and money over the practice of machining dies from tool steel. Thus zinc is playing an important role in helping the aircraft industry to meet the demand of our fighting forces for "More Planes—Sooner"
Dies of unalloyed zinc were used in the days of limited aircraft production. But larger production has proved that a zinc alloy, originally developed for the die casting industry by this Company, and known as Zamak, provides additional advantages in the production of stamping dies.
The physical advantages of Zamak alloy dies include greater strength and hardness, less warpage, smoother surfaces and increased wear resistance. All of these factors contribute to longer production life, thereby cutting down the number of dies to be made—and fewer dies mean faster production.
This is just another instance of a peace-time development of zinc being turned to effective use in the War Production Program. It is also one more reason why civilian users of zinc may not be able to obtain all of the zinc products they would like to have.
THE NEW JERSEY ZINC COMPANY
MANUFACTURERS OF THE FAMOUS HORSE HEAD ZINC PRODUCTS
9 STAMPING DIES
GALVAN-IZING
1 HULL PLATES
2 RUBBER
3 PAINT
4 BRASS
5 CERAMICS
6 DIE CASTING
7 PHARMA-CEUTICALS
8 METAL SPRAYING
FOR VICTORY
BUY UNITED STATES WAR SAVINGS BONDS STAMPS
CHECKING THE MATING OF THE DIES
DETERMINING FURTHER FINISHING REQUIRED

valve is being employed in many shell-forging press installations, as well as on hydraulic presses used for other purposes. The valve has a forged-steel body and alloy-steel spindles and valve seats. The seats can be removed for grinding or replacement.

The valve has been designed to prevent loss of high-pressure fluid and to minimize any tendency to water wire-drawing of the seats and spindles. It is arranged for pilot control to speed up the forging operations. Either air or hydraulic fluid control by a small and easily operated auxiliary valve can be used. 69

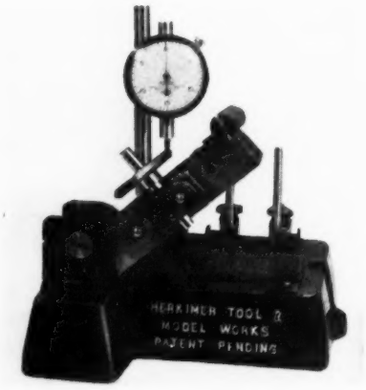


Fig. 1. Herkimer Sine-bar Unit for Gaging Bevel Gears

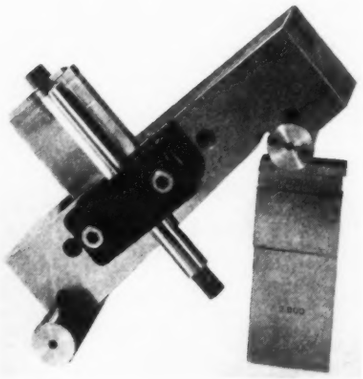


Fig. 2. Sine Bar Used with Gage-blocks for Checking Bevel Gear

Sine Bars for Gaging Bevel Gears

A new method designed to reduce the gaging of bevel gears to its simplest form, and sine-bar gages with which to perform the simple gaging operations, are being offered to the trade by the Herkimer Tool & Model Works, 113-115 George St., Herkimer, N. Y. From Figs. 1 and 2, it will be noted that the gages are provided with an aligning seat, which will receive and align either a special apex-defining set-up bar or a mandrel on which the gear blank to be measured can be mounted.

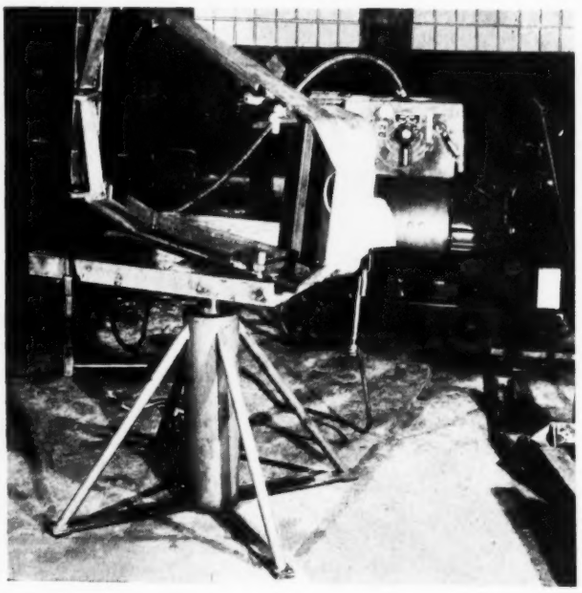
The set-up bar, shown in Fig. 2, is used in conjunction with gage-blocks to define a plane passing through the apex of the gear cone of the bevel gear, as related to the thrust face of the gear hub. This set-up can be made from dimensions usually given on drawings for bevel gears, and a direct reading with a dial indicator can be taken to secure precision gaging. As no involved calculations are necessary, this gaging method can be performed by anyone familiar with blueprint reading and ordinary gaging practice.

The gaging functions that can be performed with these tools in one set-up are as follows: Check dimensional accuracy of addendum cone (gear face) as related to thrust face of hub; check accuracy of cone angle; and check run-out of gear face. These tools are being offered in two models — one, Fig. 2, for use on a surface plate, and the other, Fig. 1, being a self-contained unit having its own base, set-up anvil, and gage-rod holders. 70

Lyon Welding Table

A hydraulically elevated welding table with revolving top, designed to enable the operator to keep the work at the most convenient welding heights, has been developed by the Lyon-Raymond Corporation, 943 Madison St., Greene, N. Y. The height is adjusted by a foot-operated hydraulic pump, and the table can be easily turned to bring the work into any desired position.

The standard stock size table has a capacity of 2000 pounds. The platform is 30 by 30 inches, and can be lowered to a height of 26 inches or elevated to a height of 40 inches. The table can be moved about the plant. 71



Lyon Welding Table Adjustable for Height by Means of Foot-operated Hydraulic Pump

Carboloy-Tipped Gun-Barrel Drills

Approved for Publication by the War Department

Carboloy-tipped drills for drilling 0.30- and 0.50-caliber and 20-millimeter gun barrels are being produced by the Carboloy Company, Inc., Detroit, Mich. The drills are furnished with the Carboloy tips brazed to short steel shanks, which, in turn, are attached by the users to their regular gun-drill tubes. The cutting edges are not finish-ground, since experience has shown that best results are obtained when the final cutting edges are ground by the individual user.

Experience with these drills indicates that an average of twenty-four 0.50-caliber barrels can be bored per grind of the carbide tip. This compares with an average of one barrel per grind for the drills previously employed. The results so far obtained indicate that the life of Carboloy-tipped drills is approxi-

To obtain additional information on equipment described on this page, see lower part of page 234.

HOW TO DESIGN AND GRIND CHIP BREAKERS FOR CARBIDE STEEL-CUTTING TOOLS

Since Carboloy tools operate at speeds usually several times faster (generally in excess of 200 F.P.M.) than high speed steel tools, the problem of economical, safe, chip disposal is one that must be considered when employing carbides for cutting steel. Ordinarily, when machining steel, a continuous chip is produced. Easy chip disposal requires that this continuous chip be broken into relatively short lengths that can be readily removed from the machine. The most widely used type of chip breaker for this purpose is the ground-in step-type breaker.

A general guide to the design and grinding of this type is shown below. Further details are contained in the 32 page Carboloy Tool Manual, available free upon request.

9 Styles of Standard-Stock Tools Available for Cutting Steel

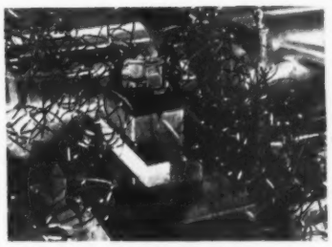
Carboloy Standard Tools—stocked for prompt delivery—include nine styles furnished in grades for cutting steel. Adaptable to 80% of all turning, boring, facing jobs, Carboloy standards can be quickly converted—in your tool grinding room—to special shapes required. One large mid-western plant, for example, uses just 9 Carboloy standard styles for 89% of all carbide tool applications in the plant. This standardization has resulted in lower tool inventory, reduced tool costs, and has enabled them to get carbide tools on the job *fast*. No delays awaiting deliveries of special shapes . . . they make their own specials by adapting standards.

Here is a typical example: Machining cast steel reduction gear blanks for the main drive of destroyers (see cut) .14 specially shaped tools required. Ordinarily that means several weeks of waiting. But this plant takes just four styles of Carboloy standards from their stock, grinds them to the 14 special shapes in an average time of less than 10 minutes per tool!

In this emergency period—when every minute counts—Carboloy Standard Tools, more than ever before, are of utmost importance to your plant. Send for catalog GT-140-R.

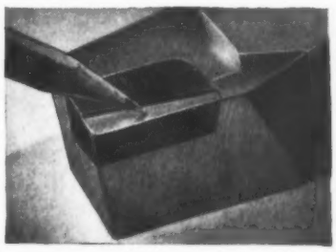
One user "makes" 14 special carbide tools for this job in less than 10 minutes per tool

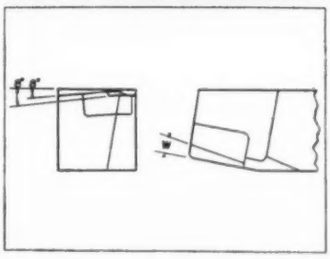
—DESIGN HINTS—



◀ At the high cutting speeds common with Carboloy tools, chips present a problem in safe, economical disposal.

The ground-in step ▶ is the most widely used type of chip breaker. Recommended for practically all kinds of steel cutting jobs.





RECOMMENDED WIDTH OF CHIP BREAKER (W)

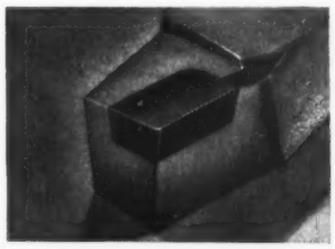
Depth Cut Inches	Feed In. Per Rev. .008–.012	.013–.017	.018–.022	.023–.027	.028–.032
1/64 – 3/64	1/16	5/64	3/32	7/64	1/8
1/16 – 1/4	3/32	1/8	5/32	11/64	3/16
5/16 – 1/2	1/8	5/32	3/16	13/64	7/32
9/16 – 3/4	5/32	3/16	7/32	15/64	1/4

NOTE: A chip breaker depth of .020 is satisfactory for most types of steel.

◀ In step-type chip breakers, it is desirable to have same rake angle on both the top surface of tip, and chip breaker.

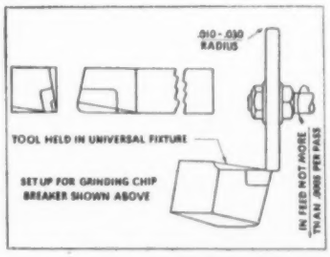
▲ Usually adjustments only in width of breaker are necessary. This table is general guide to correct widths for various feeds and depths of cut.

—GRINDING HINTS—



◀ Make sure that all tool angles have been rough and semi-finish ground to desired shape, and steel shank relieved behind tip.

Then set up tool in ▶ universal vise on a cutter, surface or chip breaker grinder. Use a 100 grit resinoid bond diamond wheel.


.010-.030 RADIUS
TOOL HELD IN UNIVERSAL FIXTURE
SET UP FOR GRINDING CHIP BREAKER SHOWN ABOVE
IN FEED NOT MORE THAN .0005 PER PASS

◀ Use kerosene or soluble oil, applied with wick, to keep diamond wheel open. Grind full width of breaker. Use down feed not exceeding .0005 per pass.

Finish grind tool ▶ shape after breaker is completed. This removes any minute nicks developed during breaker grinding.

Send for free 32-page Carboloy Tool Manual

CARBOLOY COMPANY, INC.

11147 E. 8 MILE RD., DETROIT, MICH.

Chicago • Cleveland • Los Angeles • Newark • Philadelphia
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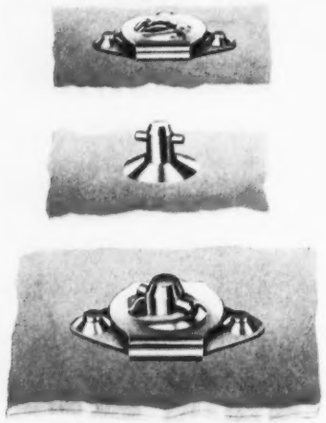
TOOLS - DIES - DRESSERS
CORE BITS - MASONRY DRILLS
- WEAR RESISTANT PARTS -

FOR THE MANUFACTURING · MINING · TRANSPORTATION · CONSTRUCTION INDUSTRIES

mately three times that of steel drills, even though the Carboloy tip is considerably shorter. This is accounted for by the fact that only about 0.010 inch of material is removed from the Carboloy tool per grind. These new drills can be attached directly to existing gun-drill tubes when the tips of the drills being used are worn off. The Carboloy tips and their steel shanks are provided with a longitudinal oil-hole. 72



Shakeproof Fastener for Aircraft Cowls

Shakeproof Fastener for Metal Plates and Covers

To meet the need for a quick, dependable method of attaching metal plates, covers, cowling, and other removable parts of airplanes, the Aviation Division of Shakeproof Inc., Chicago, Ill., has developed a cowl fastener of simplified design. A standard fastening assembly, such as shown in the illustration, consists of three parts—a main spring, stud, and cross-pin.

Only two special tools are required for the application of this fastener. First, the main spring is riveted in place over a drilled or punched clearance hole in the inner surface sheet. The stud member is inserted in a matching clearance hole in the outer sheet, and the cross-pin is then press-fitted into the stud by means of special pliers.

Upon closure of the cowling or removable part, the stud member and main spring are quickly brought into alignment. A clockwise quarter-turn locks the stud and pulls the parts together with a powerful dual spring tension. The rotation of the stud is automatically stopped in the locking position by detents in the cams of the main spring. Visual inspection can definitely determine when the fastening is in the locked position.

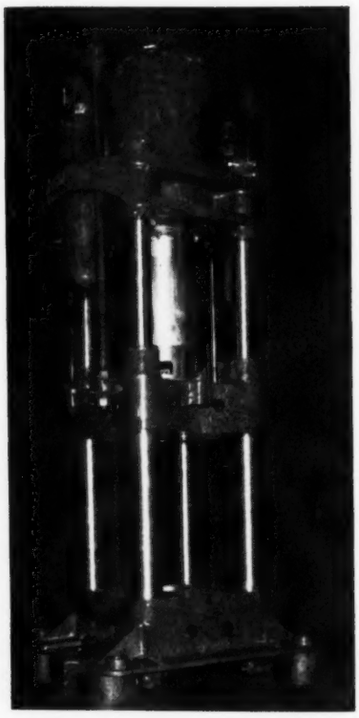
The Shakeproof cowl fastener is designed to reinforce the adjacent structural area, provide limited deflection with high initial axial tension, compensate for the usual variation in commercial aluminum sheet thicknesses, and avoid binding when used on curved surfaces. The fasteners are made in two sizes, with flush-, oval-, and wing-head studs. Standard units are available which will accommodate total material thicknesses ranging from 0.035 to 0.254 inch. 73

Baldwin Southwark 500-Ton Piercing Press

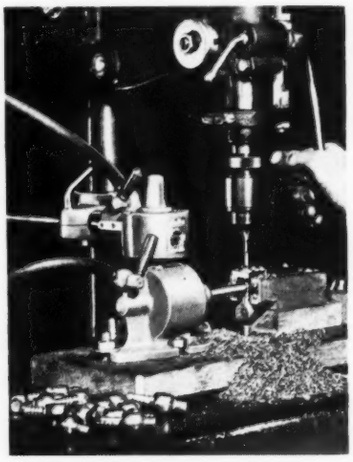
Approved for Publication by the War Department

A 500-ton piercing press of new design has just been brought out by the Baldwin Southwark Division of the Baldwin Locomotive Works, Philadelphia, Pa., for use in large shell-forging plants. The main ram of this press has a diameter of 32 inches and a stroke of 42 inches. The working pressure is 1500 pounds. The distance between platens is 99 inches, and the stripper cylinder in the bottom platen has a diameter of 12 inches.

This machine requires a floor space of 7 feet 2 inches by 6 feet. The over-all height is 25 feet 3 1/2 inches. It is finished complete with operating valves and piping. The press columns are especially designed to withstand the heavy service of 240 strokes per hour under continuous operation. 74



Baldwin Southwark 500-ton Piercing Press



Mead Air Clamps Arranged to Hold Work and Drill Jig

Mead Air Clamps

The Mead Specialties Co., Department 22, 15 S. Market St., Chicago, Ill., has brought out a line of air-operated clamps for holding down work on drilling machine tables. The clamps can be provided with foot control, which leaves the operator's hands free to locate or handle the work. This feature is especially useful when the rapid drilling or tapping of several holes in a piece is required. After each hole is drilled or tapped, the operator simply presses the foot-control pedal, which serves to release the work. The work and fixture can then be moved to the next position. When the operator removes his foot from the control pedal, the air clamp descends and holds the work firmly for the next drilling or tapping operation.

The accompanying illustration shows two different models of the air clamp, which, supplementing each other, more than double the output of the drill press. In this case, a 5/32-inch hole is drilled to a depth of a little more than 1 inch in the intake end of a brass valve

To obtain additional information on equipment described on this page, see lower part of page 234.

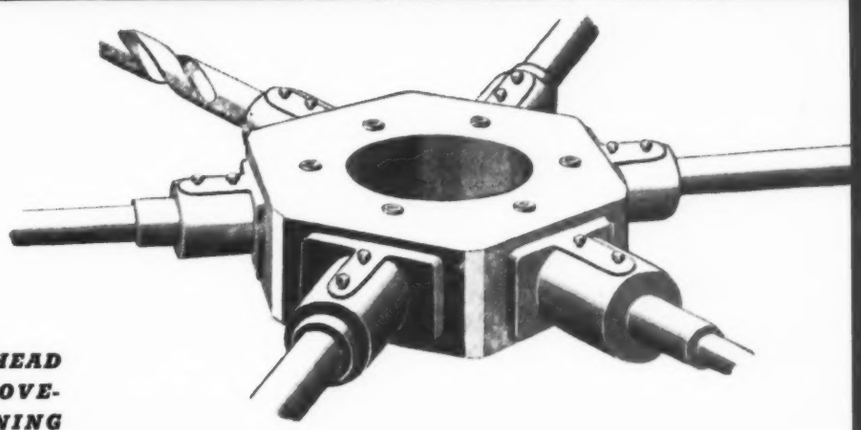
Those boys are looking to me!"

"They're shooting the works, those fellows! Gambling everything. They're 'fronting' for *me* ... my own kid brother among 'em!

"I feel as though their eyes were on me. Asking 'How much—how soon?' . . . for ordnance, airplanes, tanks, ships, trucks. There must be no shortage of the equipment and materials they need to win.

"That's our job—*my* job—to keep 'em flying ... rolling . . . marching! *Better* equipment and more of it!

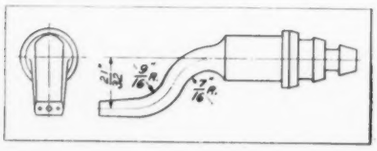
"All right! If it's a war of machines they want, that's right down my alley. My lathe can take it. So can I!"



LOOK AHEAD . . . KEEP AHEAD . . . WITH GISHOLT IMPROVEMENTS IN METAL TURNING

GISHOLT MACHINE COMPANY, 1209 EAST WASHINGTON AVENUE, MADISON, WISCONSIN

TURRET LATHES · AUTOMATIC LATHES · BALANCING MACHINES



Airco Offset Flame-cutting Tip

body. The fixture consists simply of a hard-wood base, with a built-up block in one end which has a vertical V-notch lined with steel for locating the shank of the valve body. On top of this block, there is a steel plate with a hardened drill bushing.

A Model H4 air clamp holds the valve body in the vertical V-notch during the drilling operation. A Model 4X air clamp mounted on the column of the drill press holds the entire fixture in position on the drilling machine table. This air clamp is left in the "on" position while the fixture is in use. In this case, no foot control is used. 75

Duro Precision Bench Milling Machine

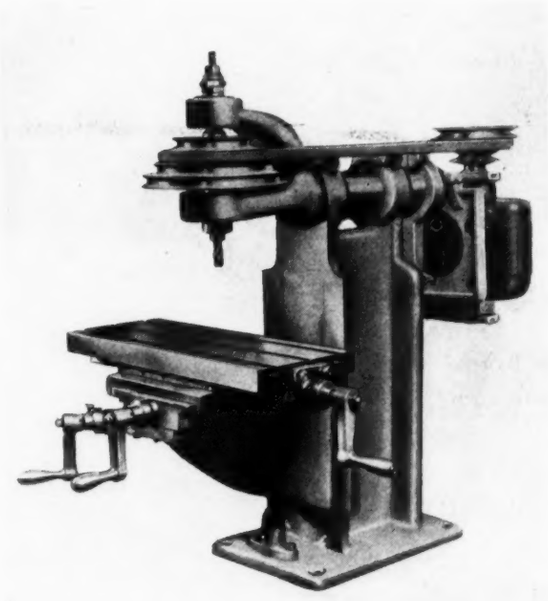
A precision vertical bench milling machine adapted for either tool-room or high-speed production work has been introduced on the market by the Duro Mfg. Co., 800 E. 61st St., Los Angeles, Calif. This machine has a precision taper roller-bearing equipped spindle. Micrometer adjustments for each direction of table movement are operated by conveniently located handles. The vertical travel of the table is 7 inches, longitudinal travel 8 inches, and transverse travel 5 inches.

The one-piece solid spindle-supporting arm is equipped with an adjustable graduated dial and index-pin. Adjustment can be made to 60 degrees each side of the center position. The extra heavy frame and spindle arm will permit accurate machining to within 0.001 inch. A unique "floating" motor mount serves to maintain proper tension of the V-belt and permit instant manual changing of the four spindle speeds of 450, 850, 1400, and 2100 R.P.M. 76

Airco Flame-Cutting Tips

Two oxy-acetylene flame-cutting tips have been added to the line of Air Reduction, 60 E. 42nd St., New York City. The first, known as Style 108, is intended for use in close quarters. It is bent to an offset shape, as shown in the illustration, to permit cutting along a line 21/32 inch from the vertical center line of the torch head or barrel. The offset design facilitates cutting close to bulkheads, flanges, or shoulders, where the radius of the torch head would prevent alignment of the cutting orifice vertically over the desired line of cut. This style tip has milled flat sides, with two preheat flames, and is suitable for either machine- or hand-cutting operations. It is available at present in sizes Nos. 1 to 3 for cutting steel 1 1/2 inches thick.

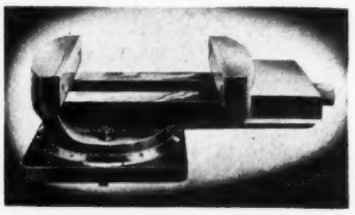
The other addition to the line is a Style 139 straight tip with one preheat orifice, designed for certain machine- or hand-cutting operations. This is a companion tip to the recently developed Style 119, which carries two preheat orifices. It is made in sizes Nos. 0 to 3. The Style 139 tip is particularly adapted for splitting angle-iron, straight-line cutting using a straightedge as a guide, or sheet-metal cutting operations, in which light preheating of the material is desired. 77



Duro Bench Milling Machine

Rouselle "Victory" Vises

The David J. Ross Co., 104 Ross Park, Benton Harbor, Mich., is placing on the market a vise to be known as the "Rouselle Victory" model. This vise is made in 7-, 10-, and 13-inch sizes. It was designed by Edward Rouselle, chief engineer of the company, to meet the demand for a heavy precision vise capable of maintaining its accuracy under mass production.



Rouselle Swivel-Base Vise

Graduations around the entire swivel-base dial permit quick, accurate setting to any angle in the horizontal plane for such operations as milling, cutting, and grinding. The largest sized vise has jaws 13 inches wide by 3 inches deep that open to a full 13-inch capacity. It requires a space of 8 1/2 by 13 by 26 inches, and weighs 250 pounds. The 10- and 7-inch sizes are of proportional dimensions and weight. 78

Ergolyte Air-Cooled Arc-Welder

To meet the need for continuous high-duty mass production welding, the Ergolyte Mfg. Co., Lawrence St. at Erie Ave., Philadelphia, Pa., has developed a new heavy-duty air-cooled arc-welder known as the Model 250F. This machine is similar to the previous 250 model, but is heavier and has a built-in air-cooling system. It will handle electrodes ranging in size from 1/16 to 3/16 inch, and has twenty-four heat step adjustments, an input of 230 volts, and a current range of 15 to 250 amperes. The 250F welder has a 60-cycle frequency and operates on a single-phase current or

To obtain additional information on equipment described on this page, see lower part of page 234.

GIVING *Wings* TO PLANE PRODUCTION

TOOL LIFE INCREASED 33%... ACCURACY AND FINISH IMPROVED *with* SUNICUT

Excessive heat and short tool life hindered production in this manufacturing plant making vital parts for combat planes. Cutting oil needs were surveyed . . . Sunicut recommended. Now work runs cooler, tool life has increased 33%, finish is improved, closer accuracy obtained — all adding up to greater output per machine unit.

This report of a Sun Oil Engineer — one of those capable "Doctors of Industry" — is typical of the service they and Sunicut are rendering to our vast war industries.

Sunicut, a clear, transparent sulphurized cutting oil, takes the heat *off* tools and work . . . puts it on production. Sunicut's transparency permits ready micrometer readings . . . easy maintenance of close tolerances.

Sun Engineers stand ready . . . willing and able to help you in your own plant. Their services . . . and the products they offer . . . are yours to use in attaining victory production. For helpful case histories of how they have aided other leaders in the metal working field, write for your free copy of "Helping Industry Help America."

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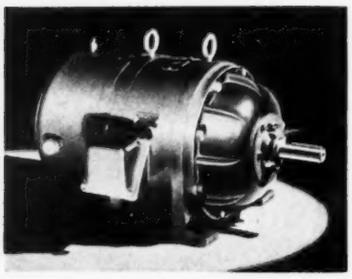
LET'S GO! U.S.A. KEEP 'EM FLYING!

SUNOCO

SUN PETROLEUM PRODUCTS HELPING INDUSTRY HELP AMERICA

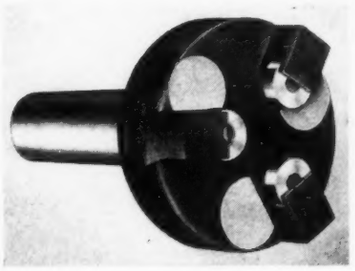


G-E Motor Designed for Safe Operation in Magnesium Dust Atmosphere

G-E Motors for Use in Magnesium Dust Atmospheres

To meet the need for motors that can be used safely under fire hazard conditions brought about by the extensive use of magnesium and aluminum, the General Electric Co., Schenectady, N. Y., has developed a new line of polyphase induction motors in sizes from 1 to 20 H.P., with NEMA frames 203 to 326, inclusive.

This line of motors is labeled as suitable for Class 2, Group E service, and has been designed for use where magnesium and aluminum dust are produced by grinding or polishing operations, and also where these metals are used in the form of fine powder. The motors are built in a totally enclosed type, with a non-ventilated construction in the smaller sizes and a fan-cooled construction in the larger sizes above 2 H.P. Dustproof construction is employed without complicating assembly. 81



Three-roller Burnishing Tool Made by the Boyar-Schultz Corporation

one phase of a two- or three-phase current. The welder can also be built to operate on special frequencies. 79

Variable-Speed Vibrator Tester

A variable-speed vibrator for use in testing the ability of any product to withstand vibration is being built by Walter A. Johnson Associates, 423 Oak Ave., Ithaca, N. Y. This machine is equipped with a Reeves variable-speed Motodrive, by which the frequency of vibration can be adjusted accurately up to 6000 cycles per minute. It has many industrial applications, but the most important uses are for testing portable radio sets, radio accessories, instruments, controls, and other similar devices.

The table has a simple harmonic motion in one plane, and the amplitude is adjustable from 0 to 0.0625 inch. The table is 18 by 18 1/2 inches, and has a capacity for testing products or equipment weighing 100 pounds or more, depending on the vibrating frequency employed. 80

Boyar-Schultz Burnishing Tool

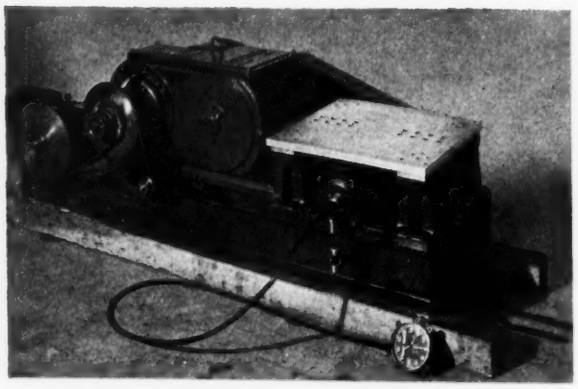
A recent addition to the line of equipment made by the Boyar-Schultz Corporation, 2110 Walnut St., Chicago, Ill., for use on screw machines is a three-roller burnishing tool, which is available in three sizes. This tool can be easily and quickly adjusted where a smoother surface is necessary than that produced by the usual machining operation.

The 00C size tool will burnish work from 1/16 to 3/8 inch in diameter and up to 1 5/32 inches long; the 0C size will burnish work 3/32 to 19/32 inch in diameter and up to 1 19/32 inches long; and the 2C size handles work 1/8 to 15/16 inch in diameter up to 2 15/32 inches long. 82

R & M Motor Drive for Machine Tools

Robbins & Myers, Inc., Department G, Springfield, Ohio, is manufacturing a motor drive that was developed over a year ago for the purpose of modernizing and increasing the production of machines of various types, particularly machine tools. Its performance has been so satisfactory that it is now being built for new machines, as well as old ones.

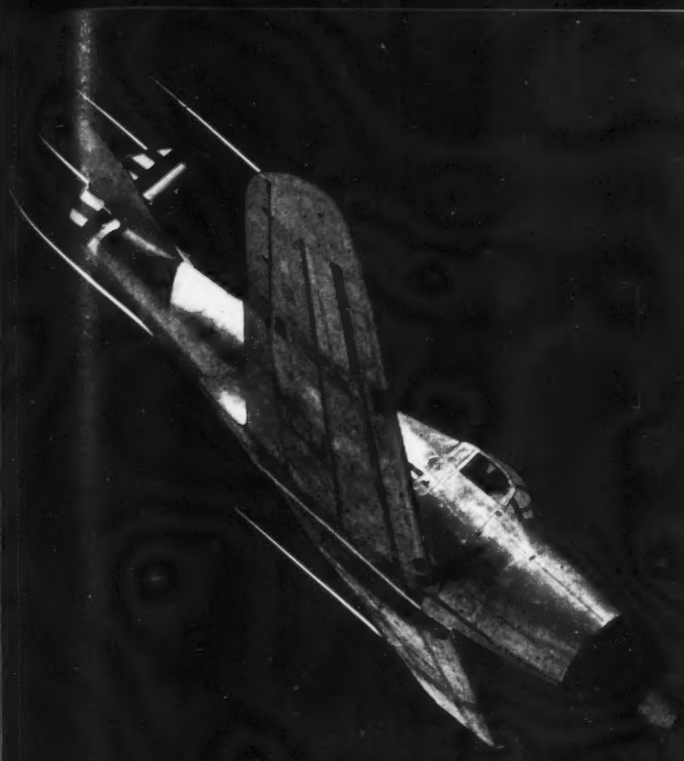
Advantages claimed for this drive are flexibility and efficiency, made possible largely by improved individual control and the elimination of lineshafts and countershafts, with attendant bearing, lubrication, and belting problems. Its installation can be accomplished by simply drilling four holes and inserting four cap-screws. Either a single- or a two-speed R & M induction motor of three-phase, 220- to 440-volt type, in sizes ranging



Johnson Variable-speed Vibrator for Testing Ability of Products to withstand Vibration

R & M Machine Drive with Reduction Gear Case Built as Part of Motor Head

To obtain additional information on equipment described on this page, see lower part of page 234.

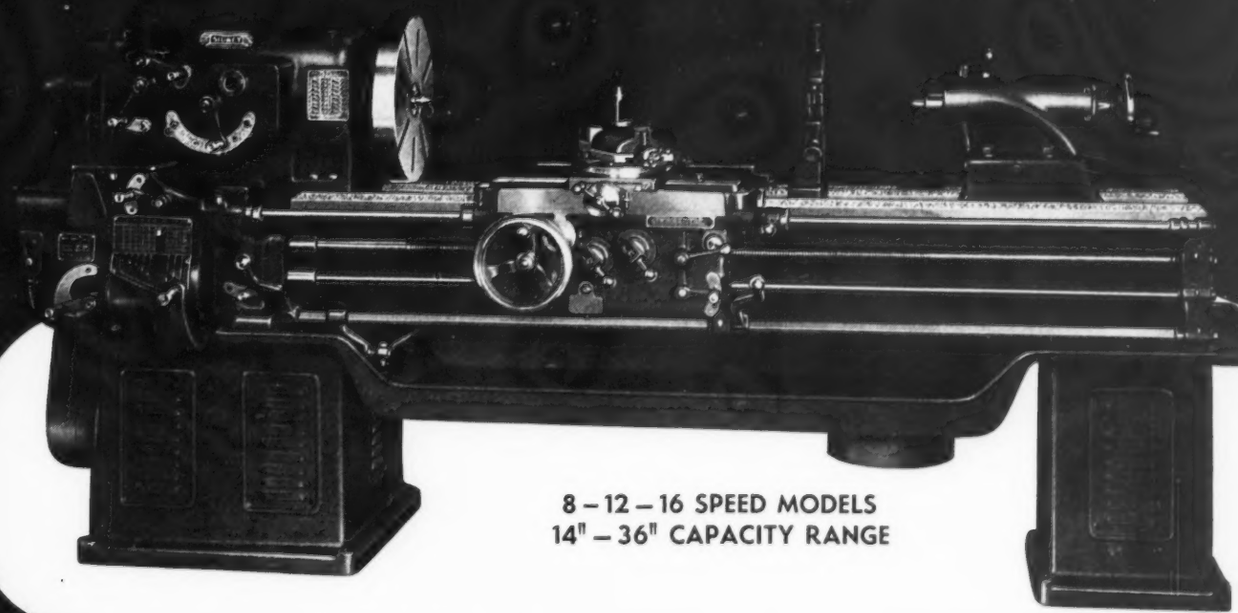


SIDNEY

THE SIDNEY MACHINE TOOL CO., SIDNEY, OHIO, U. S. A.

Both have SPEED POWER ACCURACY for DEFENSE

Bulletins available for each model lathe



8 – 12 – 16 SPEED MODELS
14" – 36" CAPACITY RANGE

For SPEED—ACCURACY—POWER and ease of operation, select SIDNEY LATHES for your DEFENSE work. Particularly in producing airplane, tank and gun parts are SIDNEY LATHES doing an important DEFENSE job.

The SIDNEY MACHINE TOOL Company

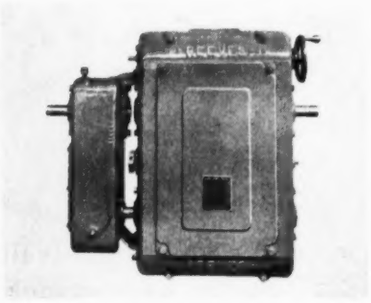
SIDNEY U.S.A. OHIO

from 1 to 7 1/2 H.P. can be used. Speed reduction is accomplished by a gear-case designed as an integral part of the motor head.

A gear shift with finger-tip control provides three speeds with the single-speed motor, and six speeds with the two-speed motor. The mounting bracket of heavy ribbed cast iron is designed to suit each application. 83

Reeves Variable-Speed Transmission with Chain-Drive Reducer

The Reeves Pulley Co., Columbus, Ind., has recently placed on the market an enclosed type variable-speed transmission equipped with a built-in chain reducer,



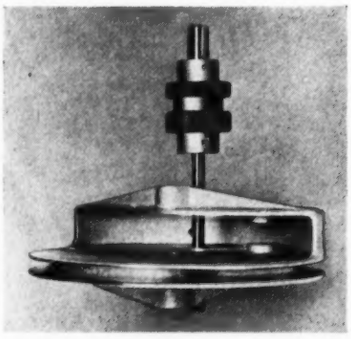
Reeves Transmission with Built-in Chain-drive Reducer

which has the output shaft in accurate alignment with the input shaft. The output speeds of this drive can be either increased or decreased, compared with the variable-speed shaft of the transmission, and can be varied within predetermined limits by turning the speed-control handwheel. The chain drive operates in an oil bath. 84

Burring Tool for Multi-Walled Parts

A new type burring tool designed for removing burrs from the inside edges of holes in multi-walled parts has been brought out by the Nobur Mfg. Co., 6156 Santa Monica Blvd., Hollywood, Calif. This burring tool, when used in a drill press, lathe, or the spindle of some other machine, is kept in continuous motion while parts are fed to it as fast as they can be handled by the operator.

It consists of a cylindrical shaft



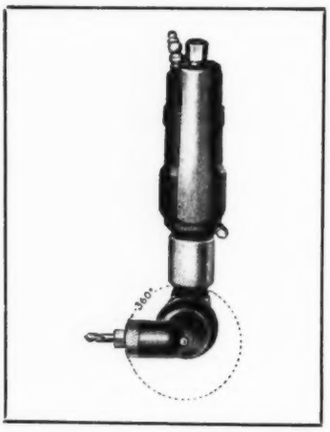
Nobur Tool Designed to Remove Burrs from Holes in Inner Walls of Work

which is piloted in the hole from which the burrs are to be removed, a knurled collar at one end of the shaft, and a retractable cutter-blade. The knurled collar is a free-rolling ball-bearing unit that can be grasped and held by the hand, even while the shaft is rotating. By sliding the collar up or down, the burring blade can be advanced into the cutting position or withdrawn.

The cutting blade is made of special tool steel, and can be easily and quickly removed for resharpening or for replacement when completely worn down. This tool is available in sizes from 3/16 to 1 inch, varying by 1/16 inch. Additional sizes and special tools can be furnished on order. 85

Cleveland Multiple-Angle Drill

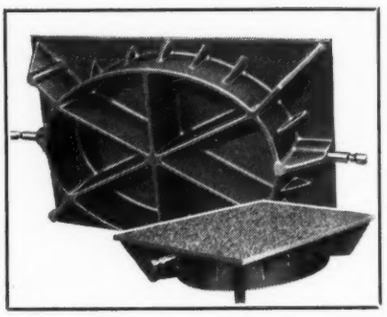
The Cleveland Pneumatic Tool Co., 3734 E. 78th St., Cleveland, Ohio, has brought out a multiple-



Cleveland Rotary Drill with Adjustable Head

angle drill in two models, designated 9D010 and 9D020. This light-weight rotary drill has a drill head that can be set at any angle through a complete circle, and can be swiveled in two planes. Thus it can be employed for work that ordinarily requires several tools. It can also be turned to any position relative to the throttle lever.

The tool can be grasped close to the point at which the drill is applied, thus permitting greater accuracy and speed in changing from one position to another. The drill weighs 2 1/2 pounds, and is about 8 inches long when set for drilling in the direction parallel to the center line. The chuck takes 1/4-inch drills. The No. 9D010 drill has a speed of 1000 R.P.M., and the No. 9D020 a speed of 2000 R.P.M. 86



Master Surface Plate Made by Smith Tool Works

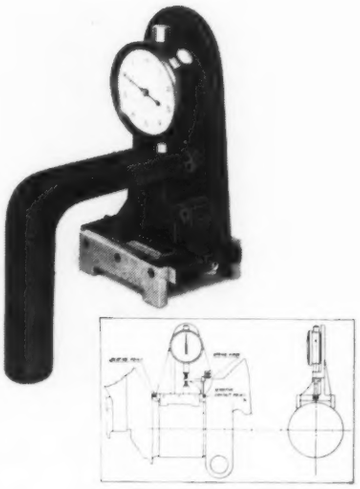
Smith Master Surface Plates

The Smith Tool Works, 826 N. Sandusky Ave., Bucyrus, Ohio, has placed on the market a line of master surface plates made from a special, fine-grained, cast steel of controlled hardness, designed to eliminate distortion. Severe working tests have indicated that these plates will maintain their accuracy over a long period of time. They are designed with a large elliptical rib, reinforced by six-point spider ribs and supporting ribs extending to the outer edges to give the plate unusual stiffness and rigidity. 87

Crankshaft Inspection Gage

A gage for inspecting the distance between faces of crankshaft bearings has just been developed by the Federal Products Corporation, 1144 Eddy St., Providence, R. I. The sensitive contact point at the right of the base is mounted

To obtain additional information on equipment described on this page, see lower part of page 234.



Indicator Type Crankshaft Gage Made by the Federal Products Corporation

on a triangular piece which is supported on flat springs to allow it to transfer the motion to the indicator without friction or lost motion. The method of applying the gage is indicated by the diagram. A master bar is furnished for testing the setting of the gage. 88

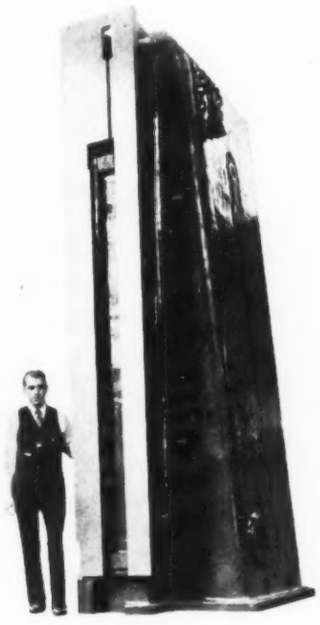
National Emergency Alloy Steels

The addition of the new National Emergency (NE) alloy steels to the warehouse stocks carried by Joseph T. Ryerson & Son, Inc., has been announced. These steels are "lean" alloy steels selected by the metallurgical staff of the War Production Board to help conserve metals like nickel, chromium, and vanadium. To make these new alloys quickly available, Joseph T. Ryerson & Son will carry a stock of hot-rolled rounds in sizes ranging from 1/2 inch to 7 inches in diameter, in six different analyses. Heretofore, these new steels have not been available for experimentation, and it has been difficult to secure even the small lots necessary for determining the suitability of the steels for given applications. Now, however, manufacturers can get small lots for heat-treating and testing purposes. This will assure the proper selection of steels, which can then be ordered in production quantities.

It is believed that the new alloy steels, properly selected and heat-treated, will satisfactorily replace the higher alloy content steels formerly used, except for very special applications. As mentioned, they are available in six analyses, two of which are carburizing alloy steels, two medium hardening alloys, and two high hardening steels.

The carburizing grades, known as NE 4023 and NE 8620, replace the S A E steels 2300, 2500, 3100, 4100, 4600, 5100, and 6100. The medium hardening grades, NE 4042 and NE 8744, replace the S A E steels 2330-35, 3130-35, 4130-35, 5130-35, and 6130-35. The high hardening grades, NE 4047 and NE 8749, replace the S A E steels 2300, 3100, 3200, 4100, 4600, and 6100.

The Metallurgical Section of the War Production Board is very anxious to know how the new NE steels serve their purpose, and conserve scarce metals. Therefore, all users are urgently requested to report details of each operation, such as forging, machining, heat-treatment response, tool life, as well as the results of tests, etc., so that this information can be made available to others. While at the present time only limited heat-treating data is on hand, the Ryerson organization will furnish all possible information with each order, to give users as much help as possible.



Massive Pyramid Housings like This 167-inch High Planer Column are being Employed on Cincinnati Hypro Planers, Vertical Boring Mills, and Planer Type Milling Machines in Place of the Former Box Type Housings

Metal Exposition in Cleveland

Owing to the fact that the exhibition space usually available in Detroit, Mich., is now being used for war production purposes, the National Metal Exposition scheduled for Detroit next October will be held in Cleveland, Ohio, instead. It will be staged in the Cleveland Public Auditorium during the week of October 12 to 16. In conjunction with the exposition, the American Society for Metals will hold its annual meeting, and the National Metal Congress, in which a number of engineering societies participate, will convene.

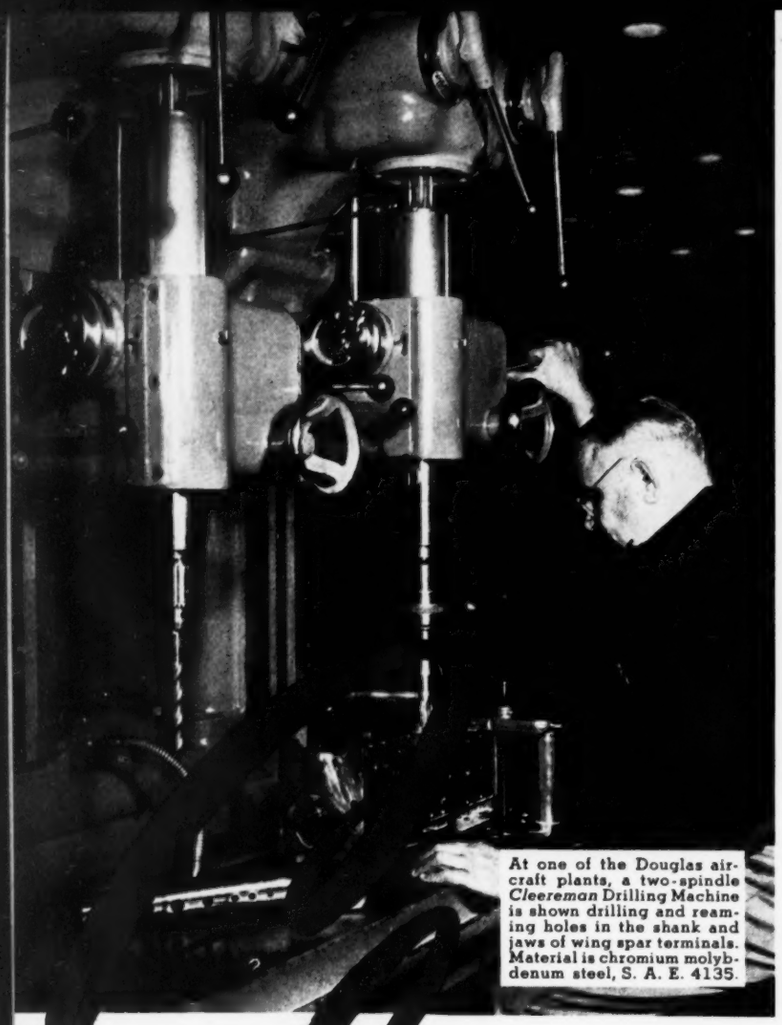
This year's exposition has properly been termed the 1942 War Production Edition of the National Metal Exposition. It will be chiefly educational in character, providing demonstrations to further increase production and to aid in more efficient planning, engineering, job training, and materials conservation, as well as to stimulate improvements of materials and substitutions for vital metals and alloys. Three other technical societies will cooperate in the National Metal Congress—the American Welding Society; the Wire Association; and the Iron and Steel Division, and Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers.

* * *

A Booklet on Priorities

A sixteen-page booklet entitled "Priorities Mobilize Production for Victory" has been published by Manning, Maxwell & Moore, Inc., Bridgeport, Conn. In this book, the subject of priorities and preference ratings is explained in ordinary business and engineering language. A great number of different Government orders of various kinds were reviewed and simplified, in preparing the booklet, so that they might be most easily used by dealers or salesmen.

To obtain additional information on equipment described on this page, see lower part of page 234.



At one of the Douglas aircraft plants, a two-spindle *Cleereman* Drilling Machine is shown drilling and reaming holes in the shank and jaws of wing spar terminals. Material is chromium molybdenum steel, S. A. E. 4135.

A *Cleereman* Dri
chine in a North
Aviation plant
finish-boring
ameters and cut
retainer groove
tail wheel housi

HIGHEST AIRCRAFT AC

Cleereman

A battery of four *Cleereman* Jig Borers used at the Consolidated Aircraft plant for accurate work on a variety of jigs, dies and fixtures.

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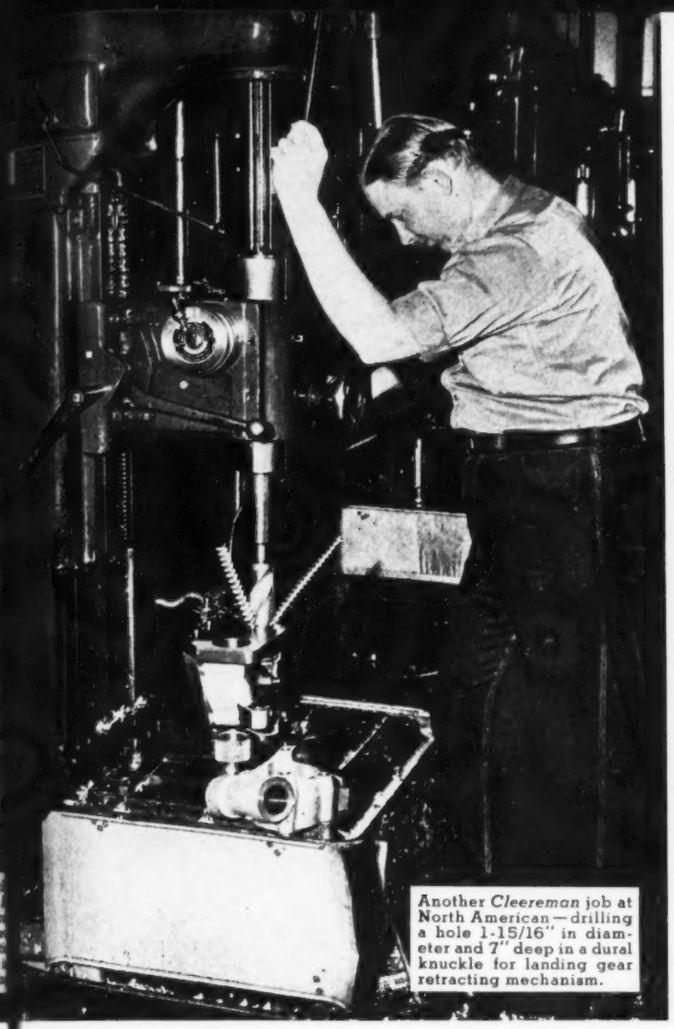


Another *Cleereman* job at North American—drilling a hole 1-15/16" in diameter and 7" deep in a dural knuckle for landing gear retracting mechanism.

At a Consolidated Aircraft plant a *Cleereman* Drilling Machine is producing 3 holes 7/8" in diameter in a manganese steel gear box. Center distances are held to +0.003 −0.000.

ACCURACY AT TOP SPEED WITH

DRILLING MACHINES AND JIG BORERS

With aircraft manufacture on a mass-production basis, interchangeable manufacture is of highest importance, and machines must be able to produce large quantities of work to high standards of precision.

Today's tremendous volume of aircraft work is proving again what *Cleereman* users already know—that *Cleereman* Drilling Machines and Jig Borers are capable of producing work to the highest degree of precision . . . of maintaining their accuracy over the most extended periods of top speed operation. The *Cleereman* Drilling Machines shown above and the battery of *Cleereman* Jig Borers shown at the left are doing some of the most accurate jobs in aircraft manufacture—on jigs and dies and on aircraft parts where accuracy must be measured in "tenths" to assure successful performance and perfect interchangeability of parts.

Designed to do the finest precision work, and built to give years of superlative service, *Cleereman* Drilling Machines and Jig Borers give the production that is needed *now*—for Victory, and the lasting accuracy that will make them equally useful when American manufacturing skill is again applied to the products of peace.

Sales Division:-

BRYANT MACHINERY & ENGINEERING CO.

400 West Madison Street

CHICAGO ILLINOIS

Westinghouse Outlines Ways to Speed Production

MORE than a score of new engineering developments and ideas, including "Seventeen Ways to Speed Production," were announced to the engineering press by the Westinghouse Electric & Mfg. Co. at a meeting held at the Hotel Astor, New York City, June 16. This demonstration illustrated the eagerness of many large corporations to share their specialized knowledge with all American industry in this national emergency.

Among the various devices and methods explained was one relating to photo-elastic stress analysis applied to turbine bolts. For the first time, three-dimensional photo-elastic analysis has been applied to the ordinary nut and bolt. In this way, it has been possible to learn how to increase the effective strength of huge turbine bolts as much as 40 per cent.

A new magnetic device for detecting under-surface flaws in steel was demonstrated. By this method heat-treated parts, like bearing races and similar cylindrical objects, are being inspected for under-surface defects by an electromagnetic test. In addition to the speed and accuracy with which the test can be performed, the advantage of this test is that it requires no contact with the inspected part and performs its task without marring or denting polished surfaces.

Another development relates to the construction of molds to meet exacting requirements for plastic parts. The various methods applied have enabled the Westinghouse mold-making department to increase the production of dies fourfold in the last year. These molds provide a low-cost, speedy way of producing intricate plastic parts.

Still another development covers an electronic method for determining the grain sizes of metallic powders for powder metallurgy. By the new method, the grain sizes of metallic powders as small as 1/25,000 inch across are determined in one-thirtieth of the time formerly required.

One of the examples related to how stamping production has been doubled and the number of rejected parts considerably reduced by the simple expedient of blowing air down through a 1/4-inch hole in the upper die. When the air is shut off, the stamping falls into the hand of the operator, eliminating the necessity of prying it loose from the lower die. Previous to using this method, it was difficult to eject the stamped pieces without injury to the finish and slowing down of production.

Other devices shown included a hollow drill for the rapid micro-sampling of engineering materials, brazed strippers which lengthen die life, and a method of tightening large bolts to an accurate predetermined tension by the application of electric heat.

A simple device for lighting deep holes and other recesses as an aid in inspection and machining operations was shown. A flashlight is attached to an 18-inch insulated copper wire inside a thin aluminum tube, the tube being flexible to accommodate the work to be lighted. The tube can be easily straightened without injury.

Output of Valves for Carbon-dioxide Fire Extinguishers has been Increased 25 Per Cent through the Use of the Simple Assembly Fixture Shown in the Illustration at the Left. The Device was Made from Scrap Iron Pipe by John Space, a Walter Kidde & Co. Employe, Who is Seen Using It. Employes are Encouraged to Develop Similar Work Simplification Devices. Literature Displays and Suggestion Boxes are a Feature of the War Production Drive in the Kidde Plant, as Seen in the View at the Right. Suggestions have Increased Fourfold where Work Simplification Classes are Held

Importance of Conserving Oxygen in Welding and Cutting

THE demand for oxygen for welding has increased tremendously during the last few months. In order to be able to furnish industry with a steady flow of oxygen, the suppliers of oxygen have found it necessary to strain their manufacturing facilities to the utmost. This is true in spite of the fact that they have considerably expanded their capacity.

In view of the increased use of oxygen, it is important that there be no waste of this gas. The Air Reduction Sales Co., New York City, from whom the information published in the following has been obtained, points out that it is almost inevitable that in the rapid expansion of oxy-acetylene welding and cutting there will be a period when wasteful practices creep in. Furthermore, the addition of thousands of inexperienced welding operators has considerably aggravated this matter of waste. Often they do not know what are the main causes of waste.

In the following are published a number of specific rules that can be used as a check-list in helping to prevent oxygen waste. The list of recommended practices is based upon observations in many oxy-acetylene welding and cutting shops. The elimination of these wasteful practices will not only relieve the pressure on the oxygen-manufacturing concerns and insure an uninterrupted supply of gas, but it will also prove economical to the shops that carefully observe the rules. One shop, for example, was inadvertently wasting approximately one-fourth of its oxygen consumption through an accumulation of losses, each of which seemed insignificant.

1. Use proper size torch tip.—A No. 2 tip used instead of a No. 1 for cutting 1/2-inch plate consumes 10 to 20 per cent more oxygen and 16 per cent more acetylene — all wasted.

2. Do not use excessive pressures.—This, one of the most common malpractices, is usually done by inexperienced operators, who believe that they thereby get a more efficient flame, or because they want to save a trip to the pressure chart. Manufacturers' rated pressures are the most efficient for average conditions; when more speed is desired, the new high-speed machine cutting tips cut faster without consuming additional oxygen.

3. Close cylinder valves when torch is not in use.—If only the torch valves are closed, the gas pressure in the hose rises and may force leaks. If leaks are already present or if new leaks occur, considerable gas will be lost.

4. Check hose and connections for leaks.—The leaks may be infinitesimal, but a 1/64-inch diameter leak in a hose operating at 100 pounds per square inch will waste 290 cubic feet of oxygen in twenty-four hours—more than a tankful. The hose should be inspected for leaks periodically by immersing it in water while under pressure. Soap and water will reveal leaks at connections.

5. Use correct diameter hose.—Hose that is too small for the job requires higher gage pressure to secure sufficient flow, causing unnecessary strain and promoting leakage in the hose.

6. Use short lengths of hose.—Unnecessarily long hose also requires higher pressure to overcome pressure drop in the hose. Also, the surplus lengths are subjected to unnecessary wear and tear.

7. Use all the gas in each cylinder before connecting a new one.—In the larger shops, interruptions of work to change tanks can be eliminated by manifolding gas cylinders or by installing pipe lines.

8. Keep cylinder inventories low.—The old custom of keeping plenty of reserve cylinders must be abandoned, for it "freezes" them at a time when rapid turnover is imperative. Gas suppliers are cooperating by providing frequent deliveries. The user can help by ordering fewer cylinders oftener, and by keeping reserves of cylinders at a minimum.

9. Return empty cylinders promptly.—Idle cylinders are production slackers.

10. Don't leave torches burning when not in use.—It may seem troublesome to be constantly relighting the torch; but if it burns idly for even as little as three minutes out of each hour, it is wasting 5 per cent of its gas consumption. Five per cent of last year's industrial oxygen consumption was 360,000,000 cubic feet. Let us use those 1,636,000 tankfuls for welding and cutting, not for heating the air.

11. Keep tips clean and free from carbon and slag.—An unclean tip is an inefficient tip, and, like any dull tool, is abhorrent to the skilled workman. Congested orifices nullify the value of using proper pressures and speeds, resulting in lower efficiency and consequent waste of gas.

12. Don't abuse cylinders. — A damaged cylinder must be taken out of circulation. It contributes nothing while undergoing repairs.

13. Handle hose with care.—Because hose is made of rubber, it is most important that it be made to last as long as possible. To insure this, it must be protected against treatment that causes leaks. Therefore, keep hose out of range of hot oxide and sparks; wash off oil and grease, which ruin rubber; place a plank on each side of the hose where it crosses truck runways; store any hose stocks in a cool, dark place; when a hose is damaged, cut out the bad portion and splice the ends together with standard splicing nipples.

* * *

Army-Navy Award Received by Cleveland Companies

On May 22, the Cleveland Twist Drill Co., Cleveland, Ohio, received the first new joint Army-Navy award for outstanding service in war production. The award consists of a naval burgee, with a blue background, having the words "Army" and "Navy" in red and a large white star in the center. Later, on the same day, the National Acme Co., also of Cleveland, received the same award. These are the first two manufacturers to receive this high honor. The employes attended the ceremonies.

REED-PRENTICE

NEW

No. 4
VERTICAL MILLER

New in design, new in performance the Reed-Prentice No. 4 Vertical Miller is built to meet the demands of today's most exacting requirements. Waste motion is eliminated. Centralized controls operate every movement of table and head, and stops can be set to control travel in all directions.

GENERAL SPECIFICATIONS

TABLE:	Working surface	24" x 70"
RANGE:	Longitudinal travel of table (Can be furnished 60")	48"
	Cross travel of ram	24"
	Vertical travel of head	12"
	End of spindle to table —	Max. 24", Min. 12"
	Throat depth	33"
	Top of table to under-side of ram ways	19¾"
MISC:	Net weight	20,150 lbs.

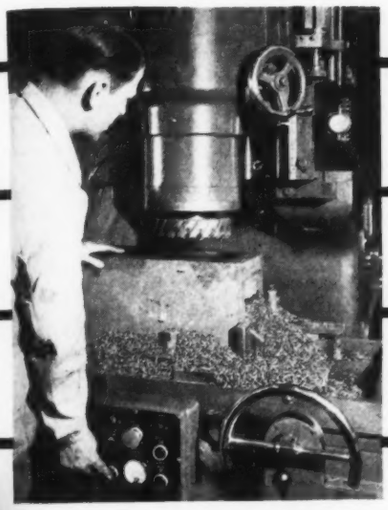
Fluid hydraulic motor driven screw insures smooth positive drive to table and cross slide with automatic acceleration and deceleration when rapid traverse motion is used.

Table ways are effectively guarded.

REED-PRENTICE CORPORATION

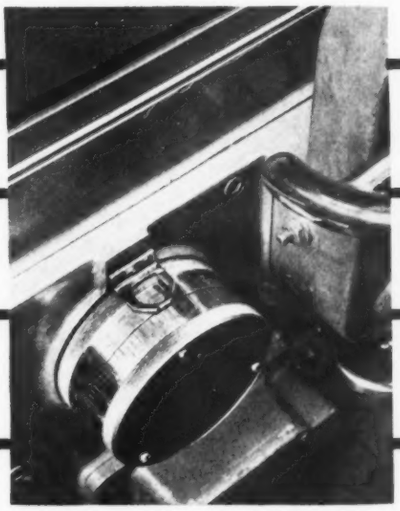
CENTRALIZED CONTROLS

All controls are within easy reach of operator. Push button station controls operation of head while dotted lines indicate positions for feed and rapid traverse control in either direction. Ammeter indicates spindle load.



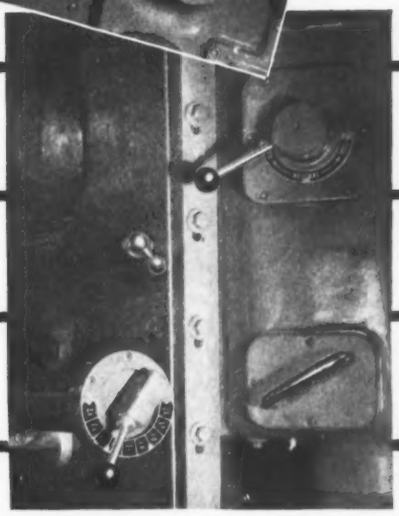
Quick Setting of Spindle Head

Head is controlled by quick traverse motor operated by push button. When used in ...nection with multiple turret stop motor ...atically shut off before head con- ... stop. Final adjustment is ...eel at upper left. Entire ... in 5 to 10 seconds.



Dual Length Reading Dials

Large dual micrometer dials accurately record in inches and thousandths of inches table and cross slide travel.



Single Lever Preselector Dial

Spindle speed is quickly selected through a direct reading preselector dial in combination with back gear lever.

TYPICAL MILLING OPERATION

Illustration shows the No. 4 Vertical Miller cutting at the rate of 20 cubic inches per minute from hard cast iron block.

WORCESTER, MASS. U. S. A.

...ON ...5 WEST ST., NEW YORK CITY 1213 W. 3d St., CLEVELAND, OHIO

NEWS OF THE INDUSTRY

California

FRAY MACHINE TOOL CO., Glendale, Calif., which has been building all the motors for its own products for several years, has established the FRAYCO ELECTRIC MOTORS CO. for the exclusive manufacture of a complete line of motors ranging from 1/3 to 7 1/2 H.P. The company will specialize in the production of motors with special end bells for manufacturers of machine tools. A new plant has been acquired at 1709 Standard Ave., Glendale, containing 15,000 square feet of space. The manager of the new company is O. W. WEYMAN.

Illinois

RICHARD F. BERGMANN has been appointed chief engineer of the Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill., succeeding WILLIAM W. SAYERS, who has been appointed consulting engineer. Mr. Bergmann was assistant to Mr. Sayers from 1933 to 1936, when he resigned to become chief engineer of the Rayon Machinery Corporation, Cleveland, Ohio, from which position he now returns to the Link-Belt organization. Mr. Sayers has been associated with the company for thirty-nine years, holding numerous responsible positions.

J. A. DANNER, industrial sales promoter for the Standard Oil Co. of Indiana's Chicago Division, has retired under the company's pension plan. Mr. Danner was connected with the Standard Oil Co. for twenty-six and one-half years. HARRY G. STILES, assistant promoter of industrial sales, will succeed Mr. Danner.

DRIVE-ALL MFG. CO., Detroit, Mich., has opened a branch office in Chicago at 30 LaSalle St. The manager of the new office is RALPH GRIFFITH, and other members of the staff are TRYGVE JOHANSEN, HAROLD WILSON, and BERNARD GLEESON.

Michigan and Wisconsin

HOWARD E. MILLS has been appointed district sales manager of the Wickman Corporation, 15533 Woodrow Wilson Ave., Detroit, Mich., in the midwestern territory, with headquarters in Chicago. From 1927 to 1941, Mr. Mills was associated in executive capacities with the National Automatic Tool Co. of Richmond, Ind. For the last year, he has been a member of the industrial staff of the Cramer-Krasselt Co., Milwaukee, Wis. In his new position, Mr. Mills will handle the sales of the Wickman high-precision (Swiss type) automatic and the Wickman optical form grinder. PAUL E. CHATELAIN has been placed in charge of engineering development of the machine tools manufactured by the company. Mr. Chatelain is engineer on special assignment for the A. C. Wickman Co., Ltd., of Coventry, England.

PAUL HACKER has joined the Pioneer Engineering & Mfg. Co., Detroit, Mich., as pump engineer in charge of sales. He has been connected with the Packard Motor Car Co. for twenty-seven years as foreman of the toolmaking department, and later of the processing department.

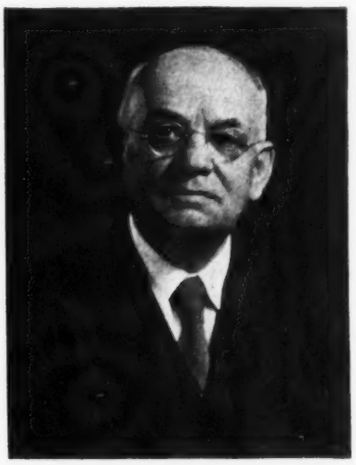
ROBERT C. ONAN, of the Lindberg Engineering Co., Chicago, Ill., has been appointed district sales manager of that company in the territory covering northern Illinois, Iowa, Wisconsin, and Minnesota. He will be located at the company's office at 606 W. Wisconsin Ave., Milwaukee, Wis.

WILLIAM C. JOHNSON, sales manager of the crushing and cement division of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been made manager of the company's general sales organization. In this position Mr. Johnson will direct the sales of 1600 different products and the operations of sixty district offices.

William C. Johnson, General Sales Manager, Allis-Chalmers Mfg. Co.

New England

J. W. RATHBUN, manager of the S. W. Card Mfg. Co. Division of Union Twist Drill Co., Mansfield, Mass., has resigned his position to enjoy a well-earned rest after serving the company over forty-nine years in various capacities. Mr. Rathbun is also resigning as clerk and treasurer of the New England Drawn Steel Co., of Mansfield.



J. W. Rathbun, who is Retiring as Manager of the S. W. Card Mfg. Co.

ARTHUR W. KIMBELL, for the last fourteen years vice-president and general manager of the United-Carr Fastener Corporation, 31 Ames St., Cambridge, Mass., has been elected president of the corporation. SINCLAIR WEEKS, the retiring president, has been elected chairman of the board.

H. J. BALL, professor of textile engineering, Lowell Textile Institute, Lowell, Mass., has been elected president of the American Society for Testing Materials for 1942 - 1943. He was vice-president from 1940 to 1942.

WILLIAM P. GWINN has been appointed assistant general manager of the Pratt & Whitney Aircraft Division of the United Aircraft Corporation, East Hartford, Conn. Mr. Gwinn has been assistant sales manager of the organization for the last two and one-half years.

ROBERT L. COE, vice-president of Chase Brass & Copper Co., Inc., Waterbury, Conn., has been elected president of the Copper and Brass Research Association.

Here's a "Short-Cutter" That Speeds Aircraft Production

Quickwork-Whiting No. 20 Rotary Shear in the plant of North American Aviation.

cuts narrow strips
cuts odd shapes
cuts straight lines
cuts openings
cuts circles—flanges
cuts irregular contours

IT CUTS Production Time

12 Models—Capacities up to 1" Mild Steel

The QUICKWORK-WHITING ROTARY SHEAR

Quickwork-Whiting Division

WHITING CORPORATION

15673 Lathrop Ave., Harvey, Ill.

New Jersey

MANHATTAN RUBBER MFG. DIVISION OF RAYBESTOS-MANHATTAN, INC., Passaic, N. J., has won, for the second consecutive year, the national award presented by the National Advertising Agency Network for the best business paper advertising campaign. The presentation was made at the annual convention of the Network, held in St. Louis in May. The keynote of the company's campaign was conservation of rubber and rubber goods.

SEABOARD ENGINEERING CO. has opened an office at 29 Church St., Paterson, N. J., to do general industrial engineering work, specializing in tool and machine design. G. J. ZURCHER is vice-president and general manager.

New York

C. W. SPITTAL has been appointed general manager and W. R. BREELER assistant general manager of the Allegheny Ludlum Steel Corporation's operations at its Dunkirk, N. Y. plants. C. COTTRELL has been made production manager of the Howard Ave. plant, and MERLE GRAHAM production manager of the Brigham Road plant in Dunkirk. Announcement is also made of the appointment of W. H. NORRIS as manager of the Watervliet, N. Y., plant, with J. Q. A. DOOLITTLE as assistant manager and G. ANDERSON as production manager.

MORRISON MACHINE PRODUCTS DIVISION OF HARDINGE BROTHERS, INC., Elmira, N. Y., has been discontinued. The products made by this division, consisting of collets, feed-fingers, pads, form tools, and cut-off tools for automatics, turret lathes, and chucking machines, will become a part of the Hardinge line, and will be sold under the name of Hardinge.

HAROLD A. KNIGHT has been appointed associate editor of *Metals and Alloys*, New York City. Mr. Knight is a graduate of Cornell College, Iowa, and the Columbia School of Journalism. He has previously been on the editorial staff of *The Iron Age* and of *Steel*, and has been metals editor for the New York *Journal of Commerce*.

C. F. PITTMAN, manager of the Motor Division of the Industrial Department of the General Electric Co., Schenectady, N. Y., has been made assistant to the manager of the Industrial Department. W. H. HENRY, who was manager of sales in the Motor Division, succeeds Mr. Pittman as manager of that division.

HAROLD V. COES, vice-president, Ford, Bacon & Davis, Inc., New York City, has been nominated for president of the American Society of Mechanical Engineers for the year 1943. Mr. Coes has been active in the Society for many years in various capacities.

F. B. DAVIS has been appointed by the Copperweld Steel Co., Warren, Ohio, manager of sales of Aristoloy alloy steels and Coppco tool steels in the Buffalo district. Mr. Davis was previously connected with the Edgar T. Ward Co.

CUMMINS DIESEL ENGINE CORPORATION, of New York City, announces that the name of the company has been changed to the ROGERS DIESEL & AIRCRAFT CORPORATION to more adequately describe the nature of its business.

TOOL-RITE MACHINE CO., INC., Brooklyn, N. Y., has removed its plant to new and larger quarters at 262-264 Greene Ave., of that city.

Ohio

LESTER ENGINEERING CO. and PHOENIX MACHINE CO., 2711 Church Ave., Cleveland, Ohio, announce the formation of LESTER-PHOENIX, INC. The address of the new concern will be the same as that of the Phoenix Machine Co. Lester-Phoenix, Inc., will act as national distributors of Lester injection molding machines and Lester-Phoenix die-casting machines. FRED C. ZIESENHEIM has been appointed sales manager of the new unit.

GEORGE KENTIS, JR., has been made chief engineer of the Yoder Co., Cleveland, Ohio, engineers and manufacturers of production metal-forming machinery. Mr. Kentis was formerly superintendent of the boring mill division. He has been with the Yoder organization for twelve years, working in various capacities in the engineering sales and service departments.

H. D. HUBBS, sales manager of the Monmouth Products Co., Cleveland, Ohio, has been elected treasurer of the company. Mr. Hubbs retains his position as sales manager.

E. E. SANBORN has been appointed manager of tool steel sales in the Cleveland territory for the Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

Pennsylvania

DR. RUSSELL E. FOX of the University of Virginia, DR. GERSON S. SCHAFFEL of Carnegie Institute of Technology, and DR. ROBERT S. WEISZ of Cornell University have been awarded fellowships to carry out original research on scientific problems of their own choosing at the Westinghouse Research Laboratories under the Westinghouse Research Fellowship plan inaugurated in 1938. The appointments under the fellowship plan are for one year, with reappointment for a second year if mutually desirable. In the past, the investigations have been in the realm of pure science, but this year the selectees have been asked to indicate the fields in which they feel qualified to contribute to war research.

GISHOLT MACHINE CO., Madison, Wis., builder of turret lathes, automatic lathes, and balancing machines, has established a branch office at 1124 Park Bldg., Pittsburgh, Pa., in order to better serve its customers in southeastern Ohio, West Virginia, western Pennsylvania, and western Maryland. W. L. SUTHERLAND will be in charge of the new office.

ALFRED SONTAG has joined the staff of the testing machine department of the Baldwin Southwark Division of the Baldwin Locomotive Works, Philadelphia, Pa. Mr. Sontag was for ten years chief engineer and sales manager of the Riehle Testing Machine Division of American Machine & Metals, Inc., East Moline, Ill. His work will be concerned with testing machine production and development.

H. N. ARBUTHNOT, formerly Detroit branch manager for the Allegheny Ludlum Steel Corporation, Pittsburgh Pa., has been appointed assistant general sales manager and transferred to Pittsburgh. J. D. MCKNIGHT will take Mr. Arbuthnot's place as manager of the Detroit district sales office, of which he was formerly assistant manager.

W. H. HOLCOMB, formerly vice-president and general manager of the Pelton Water Wheel Co., San Francisco, Calif., has been appointed assistant to the executive vice-president of the Baldwin Locomotive Works, Philadelphia, Pa.

ERGOLYTE MFG. CO. maker of alternating-current electric arc welders, has just announced the opening of a new plant at 3627 N. Lawrence St., Philadelphia, Pa. The new factory is more than twice the size of the firm's former Philadelphia plant.

RICHARD N. ARMSTRONG has joined the Tool Steel Division of the Jessop Steel Co., Washington, Pa. He was previously a member of the Iron and Steel Division of the British Purchasing Commission.

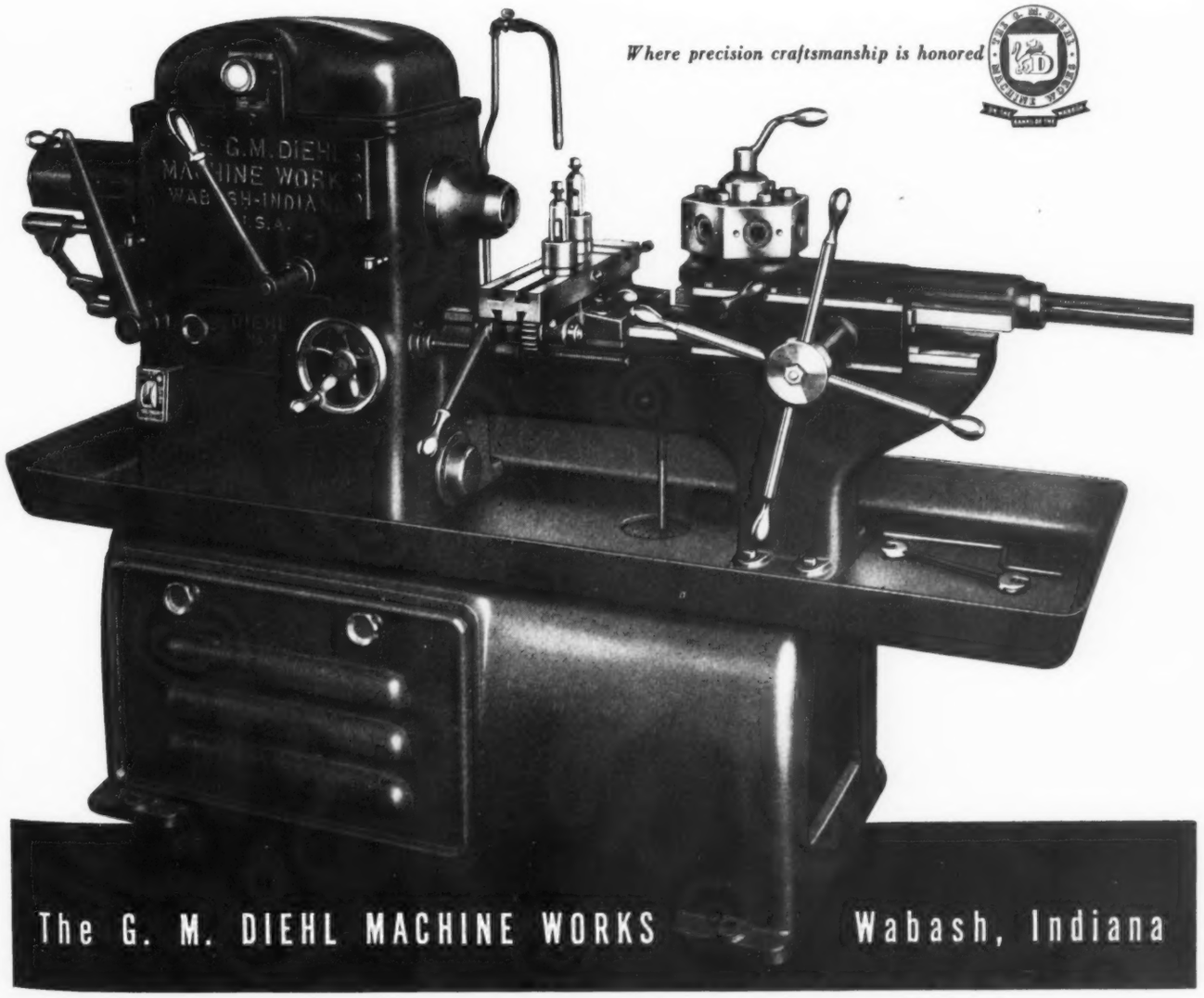
H. STURGIS POTTER, of the Indianapolis branch of the Carpenter Steel Co., has been transferred to the main office at Reading, Pa., where he will be assistant manager of tool steel sales.

DIEHL *a Great Name in a new field*

In every industry there is one name that is recognized as the leader—and in heavy woodworking machinery, that name is "Diehl". Now, because of America's desperate need for precision turret lathes in war industries, we are taking our name and reputation into the metal-working field, confident that they will be sustained by the performance of our No. 2 Turret Lathe.

The Diehl Turret Lathe is specifically designed to fit into the production scheme of plants already busy on war contracts . . . it uses the same tooling, including collets, of any other standard make No. 2 lathe. Automatic chuck capacity, (round) 1" . . . swing over cross slide, 6"; over bed, 14" . . . six speeds, forward or reverse. Power Feed available. Details on request.

Where precision craftsmanship is honored



The G. M. DIEHL MACHINE WORKS Wabash, Indiana

OBITUARIES

Hobart S. Johnson

Hobart S. Johnson, chairman of the board of directors and former president of the Gisholt Machine Co., Madison, Wis., died on May 28 at his Maple

Bluff home, aged sixty-eight years. In failing health for a number of years, Mr. Johnson resigned the Gisholt presidency in 1940, and was succeeded by his son, George H. Johnson, who is the present head of the firm, as well as president of the National Machine Tool Builders Association. Hobart Johnson was the last surviving son of the late John A. Johnson, a pioneer Madison industrialist who came to this country from Norway, and founded the Gisholt Machine Co. in 1888; he was also an organizer and one-time president of the Fuller & Johnson Mfg. Co. in Madison.

Hobart S. Johnson was born in Madison on October 7, 1873. He studied mechanical engineering at the University of Wisconsin from 1890 to 1893, when he left the university to take charge of the Gisholt Machine Co.'s machine tool exhibit at the World's Columbian Exposition in Chicago. At the close of the exposition, he entered the Gisholt shops, worked in every department, and in 1897, became shop superintendent and works manager, a capacity he filled for many years. Later he advanced to the vice-presidency, and upon the death of his brother Carl, in 1931, became president of the firm.

In 1917, Mr. Johnson, at the request of the War Department, supervised the construction and operation of the Northwest Ordnance plant in Madison. During its operation in conjunction with the Gisholt plant, of which it is now part, the ordnance works turned out 250 field guns, many of which were in service in France during the first World War. Mr. Johnson lived to see the enlargement of the Gisholt plant to meet government requirements for greater productivity in its present war work.

In 1898, he was married to Elizabeth Hopkins of New York City, who survives him. He also leaves two sons, George H. and Hobart Stanley, Jr., seven grandchildren, and a sister, Mrs. Ida Johnson Fisk.

Mr. Johnson was a member of the American Society of Mechanical Engineers, the University Club of Chicago, and various other organizations.

* * *

Farrel-Birmingham Receives Navy "E" Award

In recognition of excellence in the production of gear drives for Navy ships, the three plants of the Farrel-Birmingham Co., Inc., at Ansonia and Derby, Conn., and Buffalo, N. Y., have been awarded the Navy "E"—the traditional Navy symbol for a job well done.

The award was presented by Rear Admiral Henry A. Wiley, chairman of the Navy board for production awards, and was accepted on behalf of the company by A. G. Kessler, vice-president and general manager of the company's Buffalo plant. On behalf of all the employes, William Shea, veteran employe with sixty-two years of service to his credit, received the Navy "E" lapel emblem from Commander Robert S. Smith, Jr.

* * *

Tool Engineers Plan Meeting in Springfield, Mass.

The tenth semi-annual meeting of the American Society of Tool Engineers will be held at Springfield, Mass., October 16 and 17, with headquarters at the Hotel Kimball. The meeting will be known as the War Production Conference of the Society. There will be five technical sessions dealing with tooling for war production; substitutions for critical materials; inspection; training; and tool conservation. Frank W. Curtis, past president of the Society, is serving as general chairman of the meetings committee. Basing the estimate on previous attendance at the national meetings of the Society, it is expected that a very large number of tool engineers and production executives will participate in the meeting.

COMING EVENTS

OCTOBER 12 - 16 — NATIONAL METAL CONGRESS AND EXPOSITION in Cleveland, sponsored by the American Society for Metals. W. H. Eisenman, secretary, 7301 Euclid Ave., Cleveland.

OCTOBER 16-17 — Tenth semi-annual meeting of the AMERICAN SOCIETY OF TOOL ENGINEERS, to be known as the War Production Conference of the Society, at Springfield, Mass., with headquarters at the Hotel Kimball. Adrian L. Potter, executive secretary, 2567 W. Grand Blvd., Detroit, Mich.

NOVEMBER 17-22 — NATIONAL CHEMICAL EXPOSITION AND INDUSTRIAL CHEMICAL CONFERENCE at the Stevens Hotel, Chicago, Ill. For further information, address National Chemical Exposition, 110 N. Franklin St., Chicago, Ill.

NOVEMBER 30 - DECEMBER 3 — Annual meeting of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS at the Hotel Astor, New York City. Secretary, C. E. Davies, 29 W. 39th St., New York City.

NOVEMBER 30-DECEMBER 5—Fifteenth NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING at the Grand Central Palace, New York. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York City.

* * *

Campaign to Eliminate Oxygen Waste

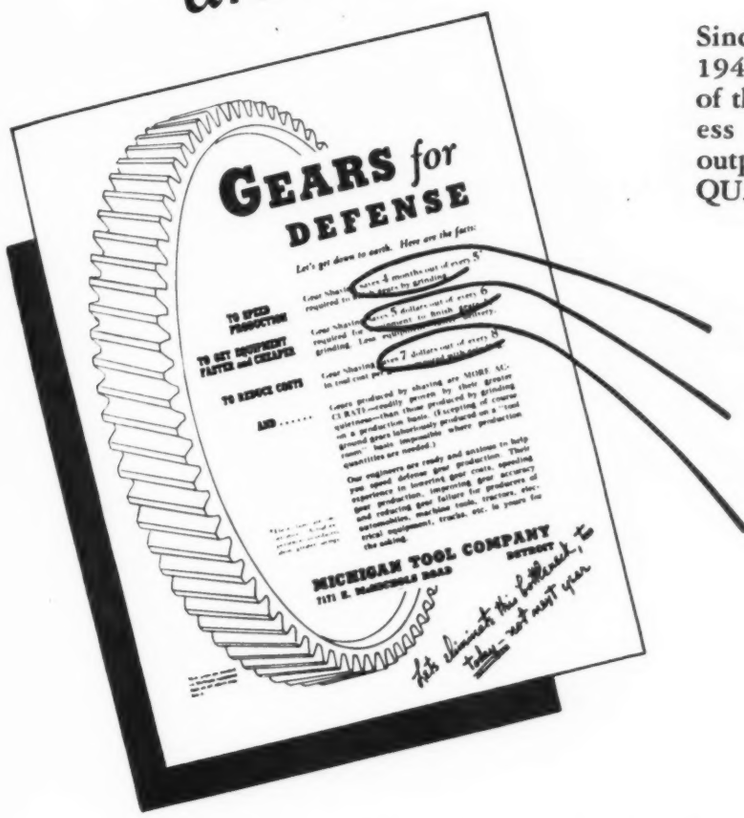
As part of a campaign against the waste of oxygen in welding and cutting operations, two posters for display in plants where oxy-acetylene processes are being used have been made available by the Air Reduction Sales Co., 60 E. 42nd St., New York City.

These posters point out the importance of oxygen in war production, and emphasize the need for its conservation. No advertising appears on either poster. Copies can be obtained without charge from the Air Reduction Sales Co.

* * *

The American Gear Manufacturers Association reports that the sales of industrial gears for May, 1942, were 54.3 per cent above May, 1941, and 11.1 per cent above April, this year. The sales for the five months ending with May, 1942, were 38 per cent above the corresponding period of 1941.

---so AERO GEARS, too are now SHAVED*---


GEARS for DEFENSE
Let's get down to earth. Here are the facts:
TO SPEED PRODUCTION
TO GET EQUIPMENT FASTER and CHEAPER
TO REDUCE COSTS
AND .....
MICHIGAN TOOL COMPANY
7171 E. McNICHOLS ROAD
DETROIT
Let's eliminate this bottleneck, Today—not next year.

Since the advertisement at left appeared in 1940, there has been widespread adoption of the "Michigan" crossed-axis shaving process for finishing aircraft gears to multiply output and cut costs—while IMPROVING QUALITY.

Saves 4/5 of the time

Saves 5/6 of the equipment cost

Saves 7/8 of the tool cost

*Most, but not all aircraft gear designs lend themselves to finishing by shaving. We will be glad to advise you whether or not your gear designs permit the use of the "Michigan" gear finishing process.

There are several types of finishers to choose from—rotary and rack—external and internal—for large gears and small gears.

A battery of "Michigan" rotaries finishing gears in the plant of one aero engine producer.

MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit, U. S. A.

NEW BOOKS AND PUBLICATIONS

MACHINE SHOP WORK. By John T. Shuman. 499 pages, 5 1/2 by 8 1/2 inches. Profusely illustrated. Published by the American Technical Society, 58th St. at Drexel Ave., Chicago, Ill. Price, $3.50.

The purpose of this book, which has been prepared by a man who directs shop work training at the Williamsport Technical Institute, is to help the beginner to obtain a better understanding of the fundamentals and principles of machine shop practice. Real progress in learning the trade cannot be made by the student or operator until he understands the basic principles underlying the use of the various tools and machines ordinarily found in the modern machine shop. The book approaches machine shop practice from the "how to do it" point of view. Emphasis is placed on the fundamentals behind the tools, especially on the so-called standard machine tools. Machine construction is also concisely covered, but it is the use of tools and the operation of machine tools in common use that are stressed. The material in the book has been selected after much experience in teaching both young men and adults.

ENGINEERING DRAWING AND MECHANISM. By Harold J. Brodie. 241 pages, 8 1/2 by 11 inches. Published by Harper & Brothers, New York City. Price, $2.25.

This text-book is one of a series prepared at the Rochester Athenaeum and Mechanics Institute as part of its program for developing teaching materials that are practical in character and closely related to the actual requirements of industrial work. The contents of the book have been evolved through twenty years of actual use in teaching, and have been prepared in close cooperation with industry. The book is published in loose-leaf binding, the text being directly reproduced from typewritten copy, and the illustrations from actual mechanical drawings.

BLUEPRINT READING. By Arthur A. Dick. 157 pages, 6 1/2 by 10 inches. Published by the Ronald Press Co., 15 E. 26th St., New York City. Price, $2.40.

This book on blueprint reading is a compilation of the teaching experience of the author. The problems have been selected from classroom practice or formulated from industrial practice. The book is planned for high schools, vocational schools, adult evening schools and teacher training institutions. It is not intended to take the place of a course in drawing, but is rather a planned teaching device whereby students can be taught to read general blueprint fundamentals in a relatively short period of time. The first part of the book gives the terminology of blueprints and describes various methods of representation. The second part gives examples of blueprints or shop drawings, together with problems in reading them, as well as sketching problems.

MACHINE SHOP MATHEMATICS. By Aaron Axelrod. 368 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $2.50.

The fundamental mathematical facts and procedures presented in this book have been especially selected and arranged to meet the needs of the machine shop worker and the apprentice. The problems presented are those that occur daily in the experiences of an apprentice. The drawings and sketches are so arranged that the student may receive training in simple blueprint reading. The treatment of formulas has been kept as simple as possible. The book is adapted for use in vocational and trade schools, as well as for home study.

The Management-Labor Production Drive Committee at the Pratt & Whitney Division, Niles-Bement-Pond Co., West Hartford, Conn. This Committee has been Functioning since the Middle of March in Response to the Request by Donald Nelson, Head of the War Production Board. The Committee Concerns Itself with Publicity, Suggestion Boxes, Slogans, Spoiled Work, Transportation, Absentees, Clean Shops, Better Use of Tools, Fire Prevention, Air Raid Protection, and Safety Provisions and Methods